AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

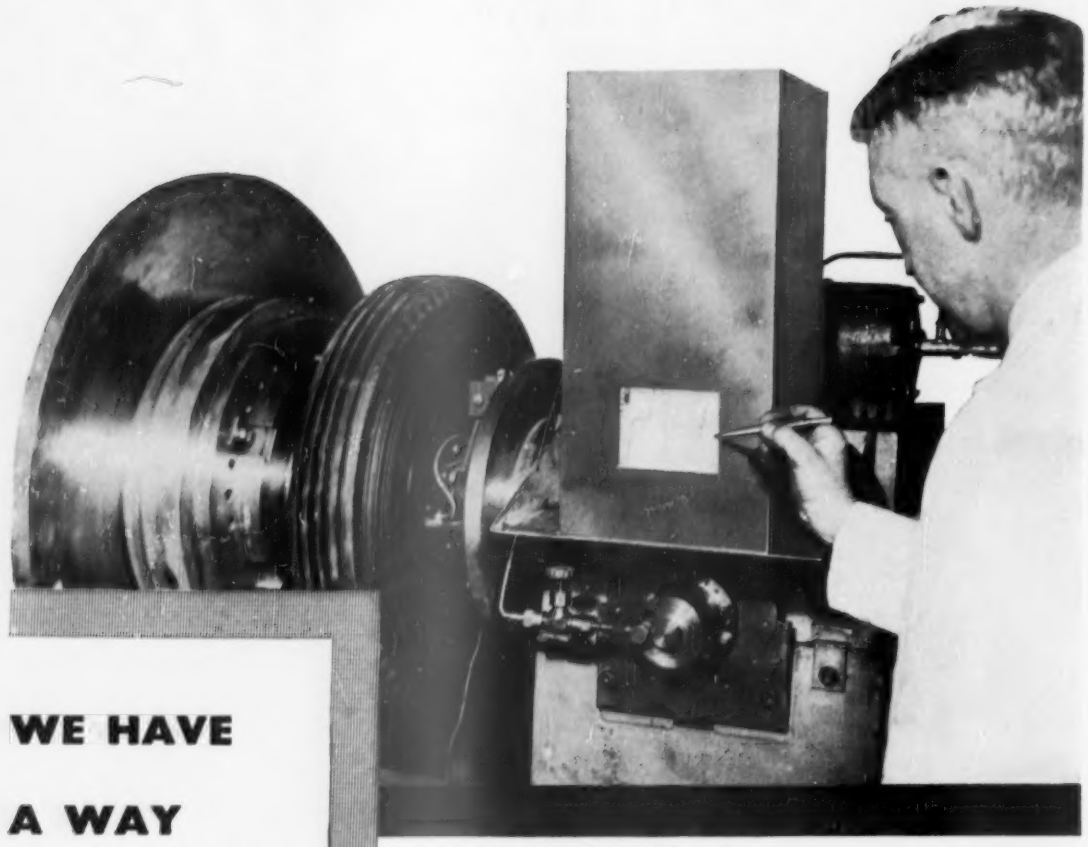
Vol. 46 No. 1 JANUARY 1956 PRICE: 3s. 6d.

SEALED

Exactly interchangeable with standard F.B.C. and other bearings. Cannot form stress-raising scratches. Sealing ring unaffected by ordinary lubricants, being of synthetic rubber. Seal can be on one or both sides. Charged with lubricant, no need to rely on some unknown user.

FISCHER BEARINGS CO., LTD., WOLVERHAMPTON

F.B.C. FBC TRADE MARK ALL-BRITISH FISCHER



WE HAVE A WAY WITH BRAKES

Into our Research Department at Cleckheaton come all manner of problems to do with brakes. Here we can reproduce the actual service conditions under which brakes operate and check performance on machines and delicate instruments which leave no room for guesswork.

The work goes on unceasingly . . . much of it devoted to anticipating the problems of the future. Mintex leadership is based securely on the work done in our laboratories and research departments.

When high performance counts

you can rely on MINTEX

MINTEX BRAKE AND CLUTCH LINERS ARE MANUFACTURED BY BRITISH BELTING & ASBESTOS LIMITED, CLECKHEATON, YORKSHIRE

"The most useful piece of equipment we have"

Typical of many such remarks applied to the Wickman Optical Profile Grinding Machine is this considered statement made by a tool-room supervisor recently. And calling to mind some of the complicated and uncertain grinding improvisations that were previously the order of the day, his satisfaction can be understood.

For the production of intricate profiles in hardened steel or tungsten carbide, for gauges, form tools and punches and split dies for press tools, there is no simpler system, nor one which offers such universal application.

The preparation of a pencil drawing of the contour 50 times larger than the form to be produced is the only preparatory work required. This is applied to the drawing table on the machine and used in conjunction with the pantograph system to trace the required profile.

A microscope is incorporated in the final arm of the pantograph whose path follows the tracing point, outlining the correct profile, the path of the grinding wheel then being traversed by manual control to the cross hair lines of the projection unit.

Accuracy of the work is not affected by wheel wear, and specially shaped wheels are not required:

INTRICATE PROFILES ACCURATELY REPRODUCED.

By the combined use of the compound slides, set to vernier scales, and the pantograph positioned microscope, profiles can be simply and positively produced to limits of accuracy frequently closer than 5/10th of a 'thou'.

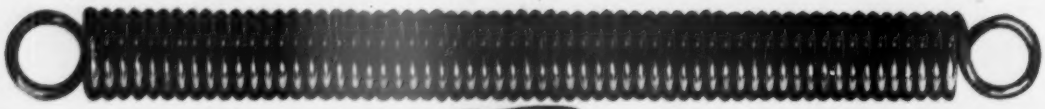
INTERNATIONAL MACHINE TOOL EXHIBITION 1956
June 22-July 6
Olympia - London

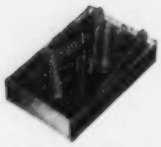
Wickman

OPTICAL PROFILE GRINDING MACHINE

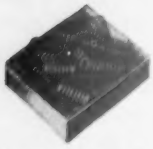
WICKMAN LIMITED

WICKMAN LIMITED, MACHINE TOOL DIVISION, BANNER LANE
COVENTRY, ENGLAND. *Telephone: Tile Hill 66271*

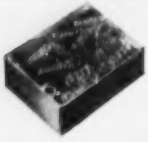




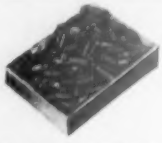
No. 760. 3 doz. Assorted Light Compression Springs 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. 6/6 each.



No. 98A. 3 doz. Assorted 1" to 4" long, ⅜" to ⅝" diam., 19G to 15G. 5/6 each.

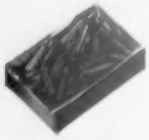


No. 757. Extra Light Compression, 1 gross assorted, ½" to ¾", ¼" to 2" long, 27 to 20 S.W.G. 15/- each.

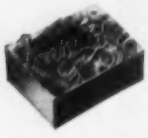


No. 388. ½ gross Assorted Small Expansion Springs. ⅜" to 1¼", 18G to 21G. 9/6 each.

No. 758. Fine Expansion Springs. 1 gross Assorted ½" to ¾", ¼" to 2" long, 27 to 20 S.W.G. 15/- each.

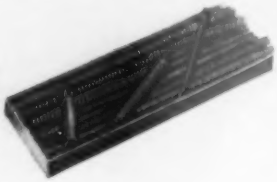


No. 466. ½ gross Assorted Small Expansion Springs ¾" to 1½" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.



No. 1024. 20 Compression Springs 12" long. ½" to ¾" diam. 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansions 1½" to 12" long. 5/32" to ½" diam., 22G to 16G. 24/- each.

No. 753. 3 doz. Assorted Light Expansion ¼" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. 10/6 each.



No. 1013. 1 gross Small Coil Compression Springs, ½" to 1½" long, 3/32" to ⅜" diam., 24G to 19G. 6/- each.

How are you off for Springs?

TERRY'S BOXES OF ASSORTED SPRINGS are just the job for your experimental department — a wonderful assortment of Compression and Expansion Springs . . . all sorts of lengths, gauges, diameters. The nine boxes we show are just a few from our range. Why not let us send you a full list—free?

TERRY'S ASSORTED SPRINGS

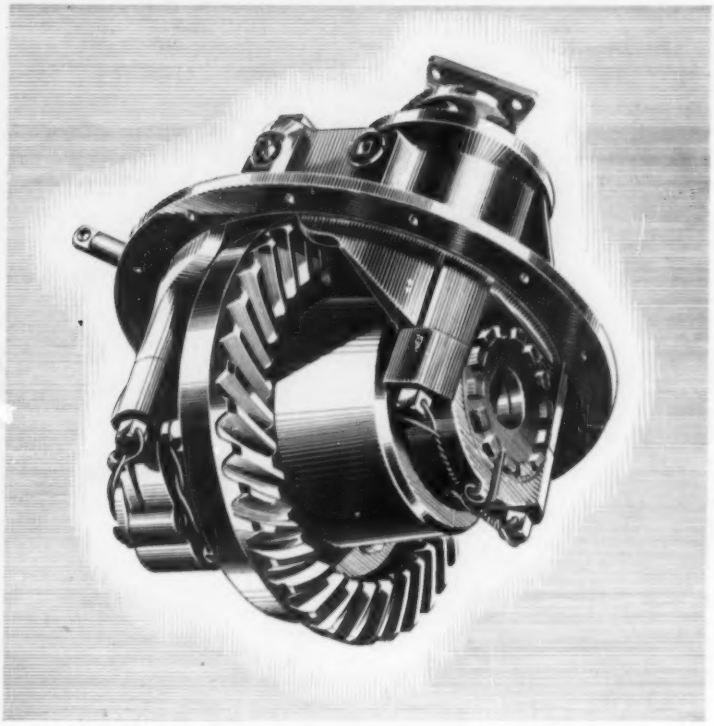
These Boxes of Springs can also be obtained at:

LONDON	27 Holborn Viaduct
MANCHESTER	279 Deansgate
BIRMINGHAM	210 Corporation Street

The prices quoted are subject to the usual trade discount.

HERBERT TERRY & SONS LTD. REDDITCH, WORCS · SPRING MAKERS FOR 100 YEARS

HT17(B)



E N V

for Gears

Specialists in spiral bevel and hypoid gears for rear axles, differential components, and assemblies, double reduction axles, automatic gear boxes and transmission gears and components. Camshafts and timing gears.

E. N. V. ENGINEERING COMPANY LIMITED *HYTHE ROAD, WILLESDEN, LONDON, N.W.10*

AP265-21A

LAYSTALL SERVICE

Just Part of the

★ **LAYSTALL - LUCAS**
ALLOY HEADS
are available for your **MG**
(Models TB, TC, TD, TF, & 1500 c.c. TF)
and **WOLSELEY 4/44**

Also
LAYSTALL CONVERSIONS
Suitable for
FORD "CONSUL" and "ZEPHYR"
and
MORRIS "OXFORD" Series II,
AUSTIN A50 and
MG MAGNETTE ZA

★
LAYSTALL CRANKSHAFTS are made in all types from refrigerators, tiny outboard motors, racing cars to vehicle and marine diesels Famous makers and famous drivers have used them for nearly 50 years.

★
Frequent stopping and starting and low temperature running are among the most serious causes of rapid cylinder wear. Hard chrome bores—CROMARD LINERS—defeat cylinder wear and lengthen the life of your entire engine. CROMARD LINERS are available for most makes of private car and commercial vehicle—petrol or diesel.

MAKERS OF THE FAMOUS
LAYSTALL
"CROMARD" LINERS

LAYSTALL ENGINEERING COMPANY LTD.
53 Great Suffolk Street, London, S.E.1.
Telephone: WATerloo 6141
Northern Branch: 63 ST. ANNE STREET, LIVERPOOL 3. Telephone: North 0178

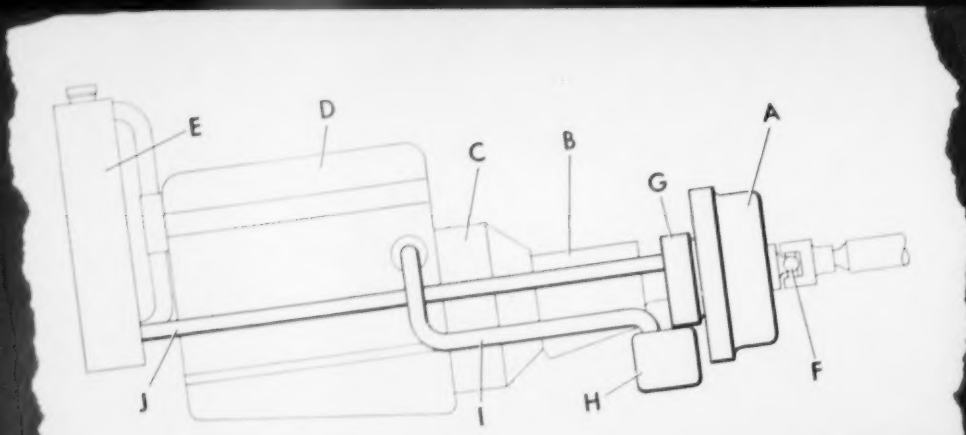
Laystall Laystall Laystall Laystall Laystall Laystall

UNMATCHED

An artist's impression of the Strap-drive Clutch. Borg & Beck Company Ltd.

Fully patented.

Regd. Trade Mark: Borg & Beck



BRAKES: Fluid Friction

In the earlier days of motoring, the final drive was a weak point and the skilled driver was supposed to use his hand-brake, acting on the rear wheels, and to save up the foot-brake, which acted through the transmission, for the real emergencies, for fear of stripping the bevels or twisting off the axle shafts. Transmission systems became improved and, especially abroad, the transmission brake again came into favour, and countless transmission brakes are bearing the brunt of heavy duty on vehicles, and everyone seems to be perfectly satisfied with them although they are rare over here.

One reason that helps us to accept in principle the transmission brake is that with present-day all-wheel braking, and the consequently increased weight transferred in braking, the maximum braking loads imposed by the rear wheels are little if any different from those imposed by maximum acceleration in bottom gear. Once we accept the transmission brake, the way is opened to many interesting adventures.

Although in earlier notes we have stressed the need for generous air cooling, that is not the whole story. When conditions get very drastic, what is needed is a ' heat reservoir ' which will accept the energy generated by a crash stop, and get rid of it even though the car is at rest and its benevolent air-stream is no longer available.

This is a factor which is not considered sufficiently seriously —every brake drum or disc, however well exposed to the air, is very hot by the time the car has made a crash stop, and there it is, retaining its heat whilst perhaps the fast driver

The diagram and short description given only by way of illustration and do not extend from any patent.

SOME BASIC CONSIDERATIONS

A fluid brake A is carried on the third motion shaft of a gearbox B connected by a clutch or fluid coupling housing C to an engine D said engine being cooled by coolant circulated through a radiator E. Said fluid brake A is driven by the final drive gearing acting through the propeller shaft upon the normal universal joint F. A control valve G in conjunction with known means such as scoops, or otherwise, controls the flow of fluid from a tank H into the fluid brake in a suitable manner for causing it to function as a fluid brake, or to cause such functioning to cease. Said fluid may be caused to flow through the radiator.

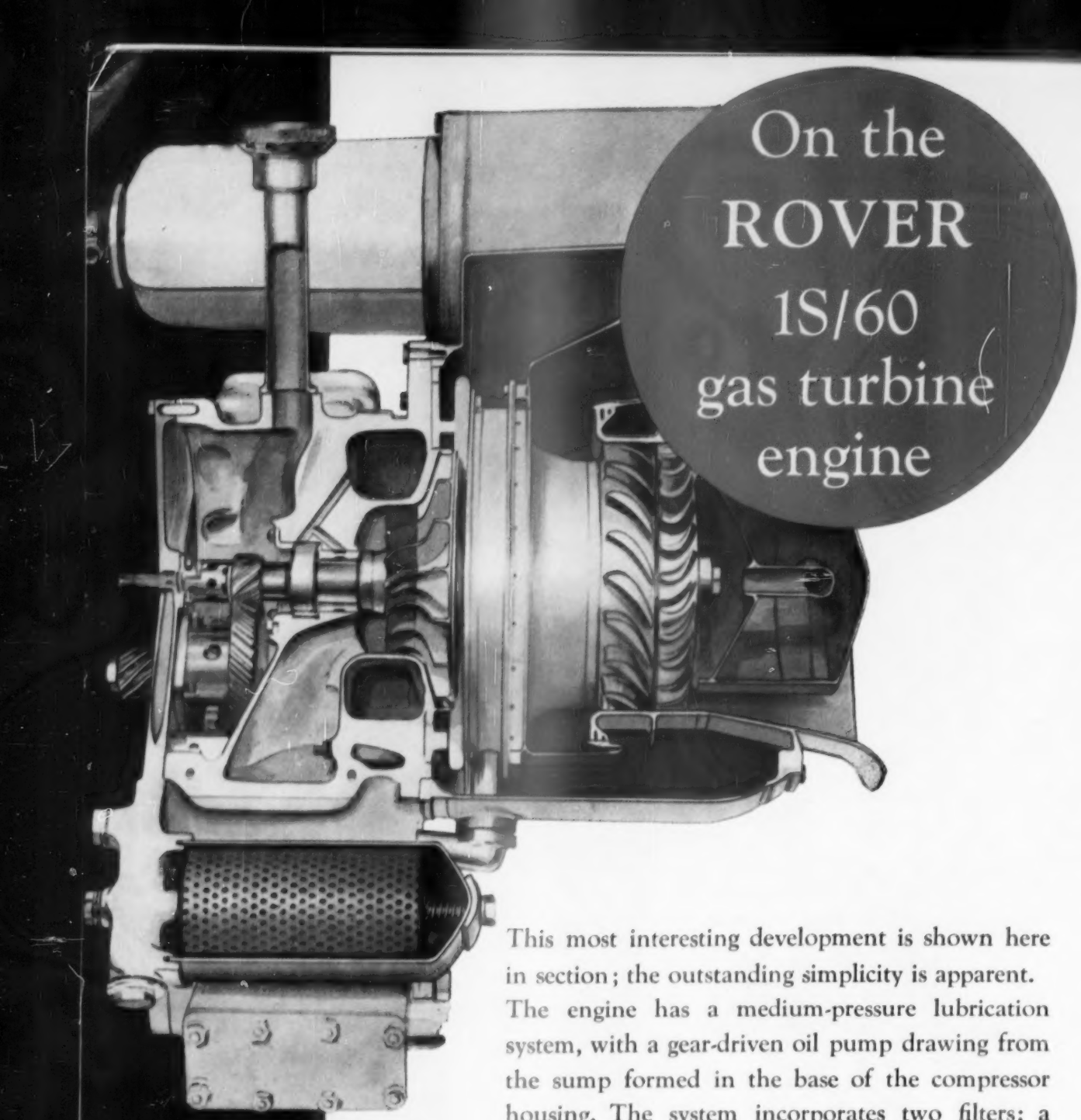
speeds up again in readiness for another crash stop. The condition is very marked, and those who have watched night racing will have seen brakes glowing the whole time whether off or on. So if the braking problem is serious we need a 'heat store'. We have envied the dynamometer its capacity for using mechanical energy to heat up a fluid, and we observe that water has a great capacity for heat; here, then, is an opportunity for killing two birds with one stone.

It is technically possible—when the dynamic-cum-economic conditions are such as to make it warrantable—to adapt the 'fluid flywheel' type of coupling to function as a brake, converting the mechanical energy by heating up the fluid. This circulates in the normal radiator, where it is cooled, since the engine is not pulling and dispersing heat during braking. Further, the effective dissipation of heat due to braking continues after the vehicle has stopped, by thermo-syphon circulation and convection. Such a brake may be engaged by controlling the fluid. Since the 'churning' resistance falls off rapidly as the relative speeds fall, there has to be a change-over from 'dynamometer' to mechanical brake: that is not difficult: the essential feature is that the major share of the energy to be dissipated is handled by the fluid brake, which can 'go on doing it forever' without noticeable mechanical wear. It is fortunate that in halving a vehicle's initial speed, three-quarters of the initial energy is dissipated, so that the fluid brake would do the lion's share.

For a high-speed motor-coach service in a mountainous district such a brake can be most effective, supplemented by good mechanical brakes. Moreover, it keeps the engine warm when going downhill, a very substantial advantage in some climates. There must be many routes where the advantages of such brakes warrant the extra cost and weight.

LOCKHEED

AUTOMOTIVE PRODUCTS COMPANY LIMITED LEAMINGTON SPA. ENGLAND



On the ROVER 1S/60 gas turbine engine

This most interesting development is shown here in section; the outstanding simplicity is apparent. The engine has a medium-pressure lubrication system, with a gear-driven oil pump drawing from the sump formed in the base of the compressor housing. The system incorporates two filters; a suction filter, to protect the pump gears, and a Purolator 'Micronic' full-flow oil filter, through which the pressure oil passes before entering the turbine oilways.

AUTOMOTIVE PRODUCTS COMPANY LIMITED
LEAMINGTON SPA, ENGLAND

PUROLATOR

'MICRONIC' OIL FILTER

Registered trade marks: Purolator, 'Micronic'

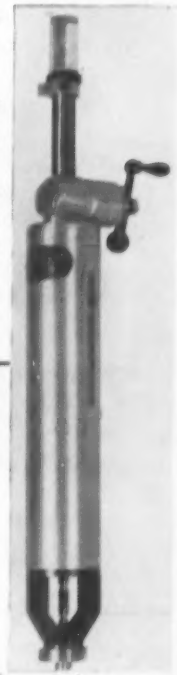
Ensures correct alignment

Shcuse me! There are timesh when shpractically imposhible shtay upright. Drillin' holes frinstance nawkward places. Drill waggles about. Men saying "From me" and "Over-a-bit-George" to get correct aligament . . . get erect liniment — keep dam thing straight. Most confusing.

But NEVER AGAIN! Oh no!
Ev'ybody use my wunnerful Rack Frill Dreeds . . . Drack Rill Feeds . . . Frack . . .
Buy HUNDREDS of 'em. Wunnerful.
Keep you straight . . .

(At this point the Managing Director curled up on the ground and passed into a deep slumber).

Correct alignment of the new Desoutter Pneumatic Rackfeed Drill is ensured by the bayonet nose attachment. Once locked on to the jig plate, the drill will apply a load of 250 lbs. with finger-tip pressure only. It will bore holes up to ¼" diameter through four inches of steel.



Desoutter RACKFEED DRILL

Desoutter Bros. Ltd., The Hyde, Hendon, London, N.W.9. **Telephone: Colindale 6346 (5 lines)** **Telegrams: Despnuco, Hyde, London**

CRC270

Improved Oil Sealing

Specify Weston Oil Seals and 'O' rings at the blue print stage

And for all types of replacements

WESTON
OIL SEALS

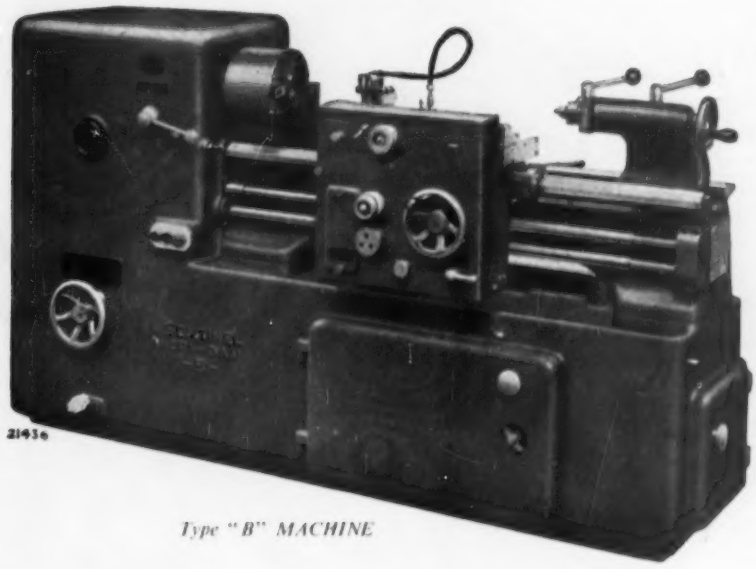
CHARLES WESTON & CO. LTD.

Irwell Bank Works Douglas Green Pendleton Salford 6.

Telephone: Pendleton 2857-8-9; Birmingham: Midland 6952; London: Holborn 0414

...Who serve you well!

HERBERT



Type "B" MACHINE

SENTINEL CRI-DAN THREADING MACHINES

These machines, which are semi-automatic, will cut external, internal, right- or left-hand, parallel, taper, single or multi-start threads of various forms and pitches in a wide range of materials, quickly, cheaply and accurately.

Setting-up is simple; design facilitates the full use of single-point *Ardoloy* or other tungsten-carbide tipped tools.

Precision threads can be cut in a fraction of the time taken on thread milling machines or centre lathes. For 400/440v, 3-phase, 50 cycles, A.C. operation.

TWO TYPES	"B"	* "E"
Maximum Thread Pitch	8 t.p.i.	2 t.p.i.
Maximum Threading Diameter external	4 ins.	12 ins.
Maximum Threading Diameter internal	6 ins. approx.	16 ins.
Length Between Centres	3 ft. 0 ins.	2 ft. 6 ins., 5 ft. 6 ins. or 8 ft. 6 ins.
Maximum Swing over Bed	13 ins.	25 ins.
Motor	5 h.p.	20 h.p.

*** IMMEDIATE DELIVERY**

Full details from:—FACTORED DIVISION, RED LANE WORKS, 'Phone: 89221

SOLE AGENTS—UNITED KINGDOM & EIRE:

ALFRED HERBERT LTD · COVENTRY

HEENAN-DYNAMATIC DYNAMOMETERS

are in widespread use for testing all kinds of prime movers. They operate upon the Eddy-Current principle and with the electronic control normally employed, very desirable torque-speed characteristics are provided.

H&F

HEENAN & FROUDE LTD · WORCESTER · ENGLAND

Jill, Joan, June, Jane and Jezebel—take five letters to my five welding suppliers

Tired of crossed letters, crossed wires and cross-talk? Clearing the snags on an automatic welding production line—and getting different answers from too many suppliers?

You'll find Quasi-Arc talk your language. A single number — Bilston 41905 — on your telephone.

Quasi-Arc Limited are the only people in the arc welding business who make and sell *everything*. They can quickly provide you with manual and automatic welding equipment, installations and supplies—everything you need, including sound technical advice. You will find them thoroughly equipped for service and research.

So send away all the girls but Jezebel. Dictate a letter to Quasi-Arc. They can deliver the goods.

The interests and activities of The Quasi-Arc Company Limited and Fusarc Limited in the well-known processes

Quasi-Arc · Fusarc · Unionmelt · Sigma
Heliarc · Twin-Arc

have been combined in order to provide a thoroughly comprehensive and effective service to the welding industry. The headquarters of the new organisation—named Quasi-Arc Limited—are at Bilston, Staffordshire, with works at Bilston and Gateshead.

Only QUASI-ARC LIMITED offer you everything

QUASI-ARC LIMITED, BILSTON, STAFFORDSHIRE

THIS IS *the tool* FOR INCREASED PRODUCTIVITY

The Armstrong Whitworth range of Rotary Air Drills embody perfect balance, low air consumption, lack of vibration, governed speed and increased power and torque.

Each tool is built to the highest Engineering standards from designs which have proved themselves in practice to stand up to the arduous conditions found in industry.

Write for Leaflet T.E.203

R.31

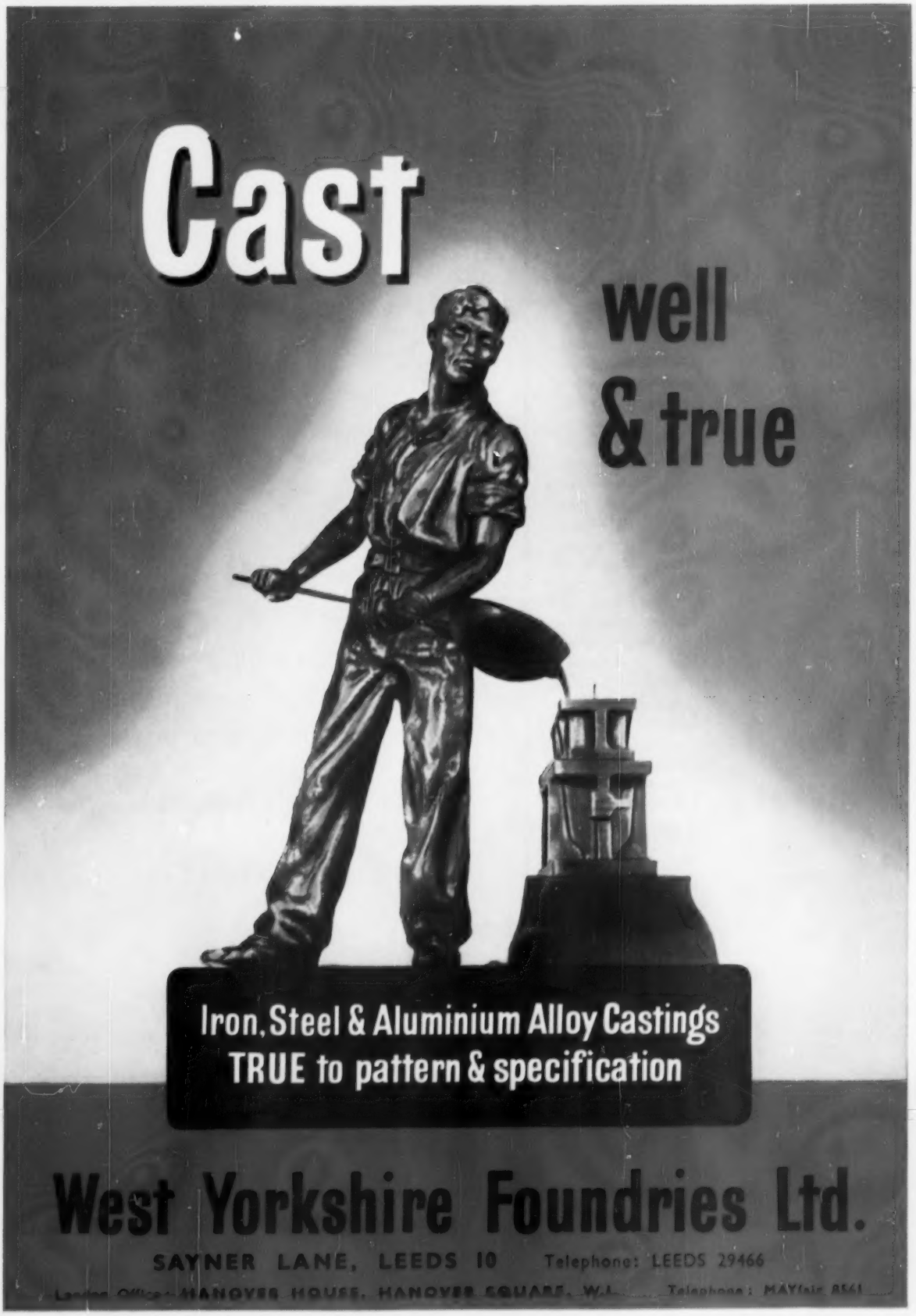
BALANCERS
DRILLS · GRINDERS · IMPACT WRENCHES
ROTARY SANDERS · RIGHT ANGLE NUT SETTERS
RIGHT ANGLE DRILLS

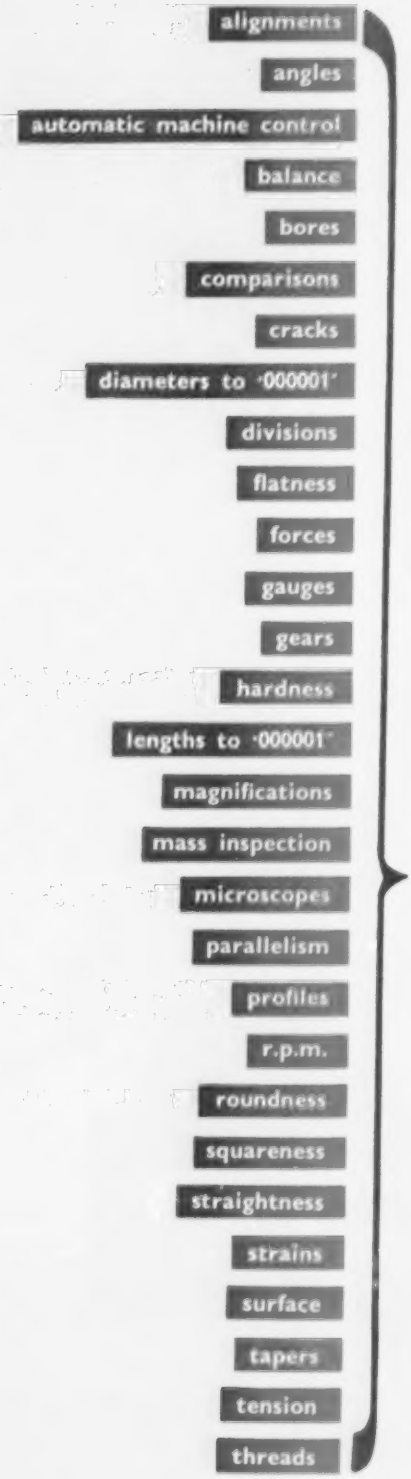
ARMSTRONG WHITWORTH
Power Tools

ARMSTRONG WHITWORTH & CO (Pneumatic Tools) LTD

Main Sales Office: 40 BROADWAY WESTMINSTER LONDON SW1
Cable Address: ARMWHITOOL SOWEST LONDON *Phone:* WHitehall 5944
Works: TYNEMOUTH ENGLAND *Phone:* NORTH SHIELDS 3111 *Grams:* ARMWHITOOL TYNEMOUTH

1603


Cast
well
& true
Iron, Steel & Aluminium Alloy Castings
TRUE to pattern & specification
West Yorkshire Foundries Ltd.
SAYNER LANE, LEEDS 10 Telephone: LEEDS 29466
Telephone: MAYfair 8561



. . . we can supply measuring and inspection equipment for all requirements and offer

a metrology service without equal;

discuss your problems with our specialists.

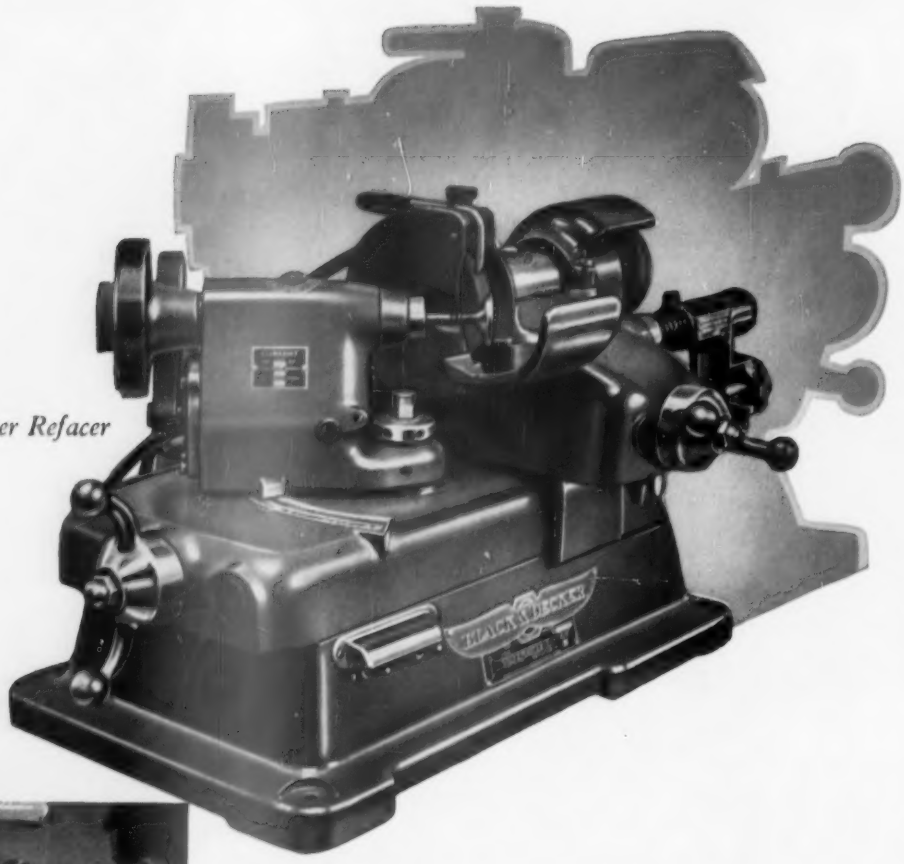
ALFRED HERBERT

ALFRED HERBERT LTD. COVENTRY are distributors for all measuring and inspection equipment made by:

SIGMA INSTRUMENT CO. LTD.
HILGER & WATTS LTD.
COVENTRY GAUGE & TOOL CO. LTD.
TAYLOR, TAYLOR & HOBSON LTD.
PITTER GAUGE & PRECISION TOOL CO. LTD.
W. & T. AVERY LTD.

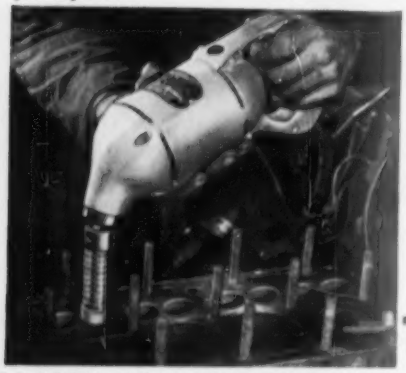
A battery of Sigma Multi-dimension Inspection Machines checking turbine-blades in the works of one of Britain's largest manufacturers of aero-engines.

LTD. COVENTRY



Valve Master Refacer

***The B&D Valve Shop** incorporates the Valve Master Refacer, the Vibro-Centric kit and the Carbon Removing kit in a transportable cabinet.* ***The 55° Vibro-Centric** Valve Seat Grinder used for working in confined spaces.*



OF COURSE YOU KNOW...

. . . that badly matched or pitted valves destroy the smooth running of an engine . . . reduce power . . . increase petrol consumption—but DO YOU KNOW that the quickest, easiest and best way of righting all valve faults is with B&D equipment. The Valve Master Refacer refaces a set of valves to any angle with mirror-smooth finish in a matter of minutes and with an attachment grinds tappets, rocker arms and Ford Valve Stems! Its sister tool the 'Vibro Centric' valve seat grinder ensures a perfect match between valve and seat every time!

Quicker and Better with

Black & Decker

PORTABLE ELECTRIC TOOLS

Write for catalogue. Demonstration of any tool on request.

BLACK & DECKER LTD • HARMONDSWORTH • MIDDLESEX

TOWSON, USA • TORONTO, CANADA • SYDNEY, AUSTRALIA • MEXICO, D.F • SAO PAULO, BRASIL

Smee's 4/53

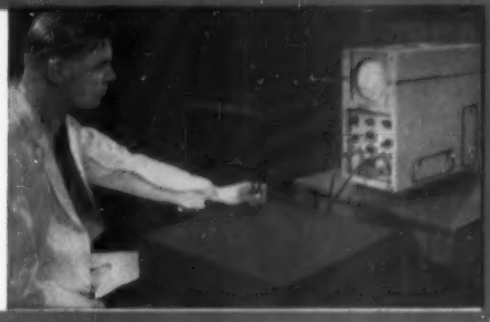
Illustration by courtesy of Birmingham Aluminium Castings (1903) Co. Ltd.

K E THERMAL FATIGUE RESISTING STEELS

FOR DIE-CASTING, EXTRUSION, STAMPING & FORGING

HOT WORKING TOOL STEELS IN ULTRASONICALLY TESTED FORGINGS...

Our recent developments in this field are the result of careful research by our Technical Staff into the call for increased productivity. Should you wish for details of our specialities please notify us so that we may arrange for one of our Technical Representatives to call upon you.



KAYSER ELLISON & CO. LTD.

CARLISLE STEEL WORKS · SHEFFIELD · ESTABLISHED 1825

BIRLEC

cuts costs

induction heating

improves product

☆ BIRLEC induction heaters in the forging industry are giving cleaner forgings, greater output and lower production costs. Maintenance is reduced and the work is of uniform high quality.

FORGING STEEL BILLETS

Hub component for a popular car, forged by the installation illustrated.

- Uniform temperature throughout each billet ensures better filling of dies with reduced flash.
- Regular, timed ejection of correctly heated billets keeps press operating at full capacity.
- Magazine feed enables one loader to supply several heater/press installations.
- Rapid heating reduces scaling, improving die life and surface finish of work.
- Quick changeover between sizes of work with correct heating conditions for each.
- Economy in power and labour, with no standby or heat-up losses.
- Space-saving layout for minimum handling and operator fatigue.

Type of heater	two station
Nominal rating	200 kw.
Heating capacity...	½ ton/hour
Billet diameter	2"—4"
Billet feed	automatic
Power (1d/kWH) ...	£2.5.0. per ton

Please send me Publication No. 125 on forging or further process details about .....

NAME .....

POSITION .....

COMPANY .....

FSB

BIRLEC LIMITED

Member of the A.E.I. Group of Companies

E R D I N G T O N

B I R M I N G H A M , 2 4

LONDON · SHEFFIELD · GLASGOW · NEWCASTLE-ON-TYNE

SM/B2500/55

Crankshaft turning on MAXIMATICS in a large automobile factory

One operator—
Two MAXIMATICS...
and high output is assured

The MAXIMATIC Multi-tool Lathe is fully automatic. Operating is simply a question of unload, load and start the machine. That's why, in many instances, one operator can easily supervise two machines. This means maximum output from your labour force, and every feature you would expect to find in an automatic lathe is incorporated to ensure fast metal removal, accuracy and dependable service on long runs.

DRUMMOND BROS. LTD.

GUILDFORD – ENGLAND

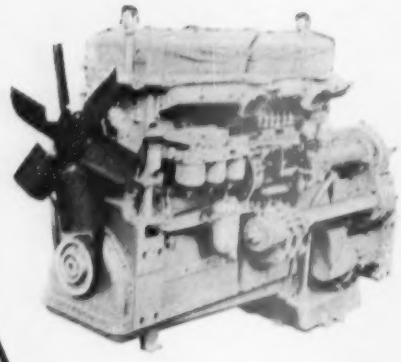
Sales & Service for . . . **DRUMMOND-ASQUITH** *. . . the British Isles*

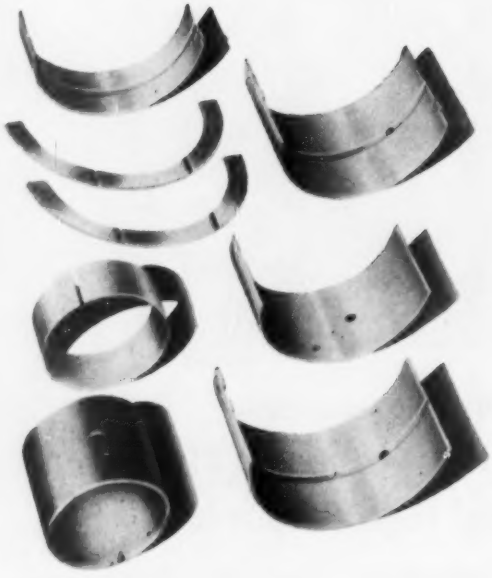
DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM
'Phone: Midland 3431 (7 lines) *Also at LONDON: 'Phone Trafalgar 7224 (3 lines) and GLASGOW: 'Phone Central 3411*

VANDERVELL

BEARINGS & BUSHES

fitted to the MEADOWS 6 D.C. 970 6 CYLINDER ENGINE





VANDERVELL LTD

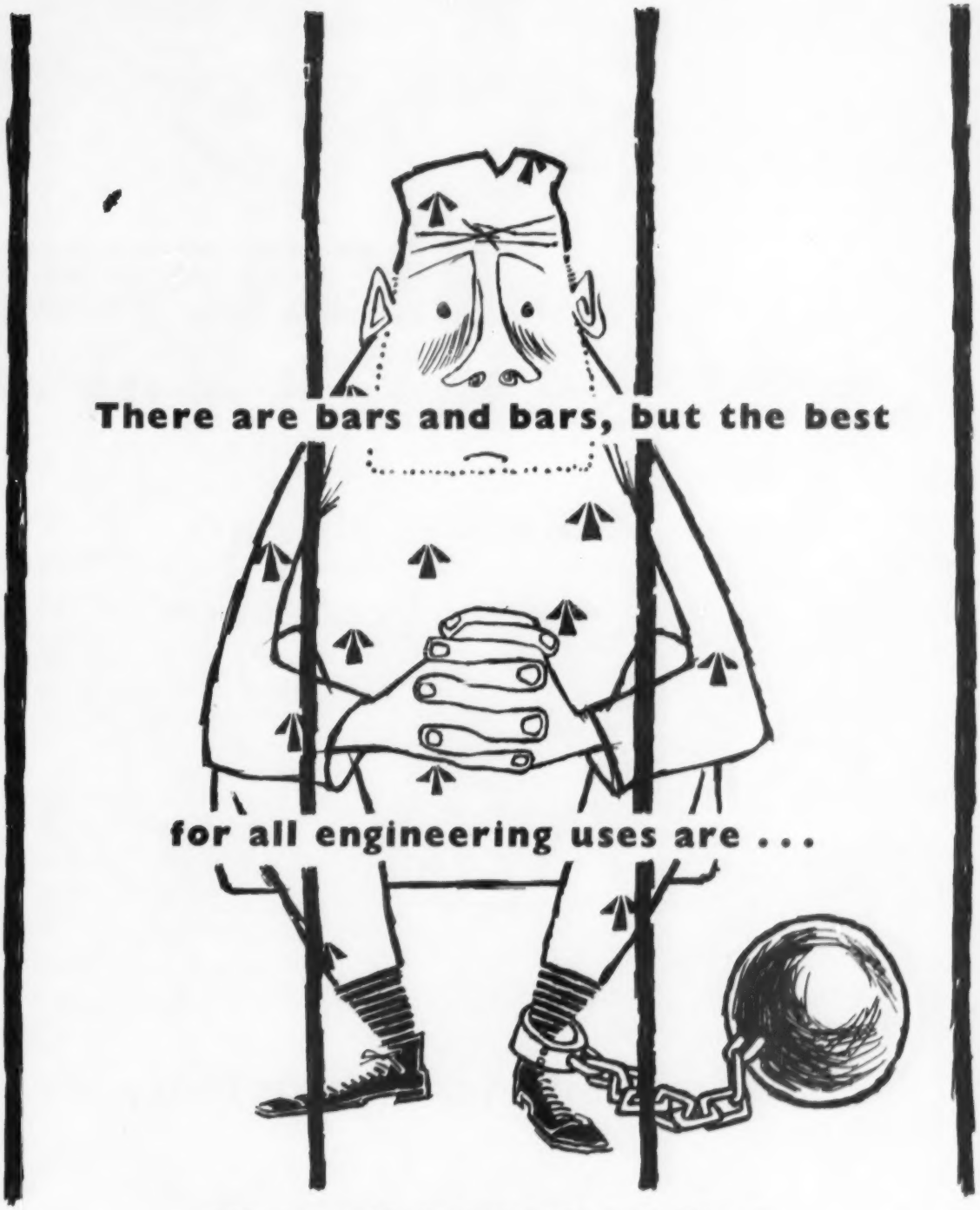
The largest producers of bearings and bushes in Europe

VANDERVELL PRODUCTS LIMITED · WESTERN AVENUE · ACTON W3 LONDON

VANDERVELL PRODUCTS (CANADA) LIMITED

QUEEN ELIZABETH HIGHWAY AT 401 KIPLING AVENUE (HOLLYWOOD POST OFFICE) TORONTO CANADA

Smee's V 106

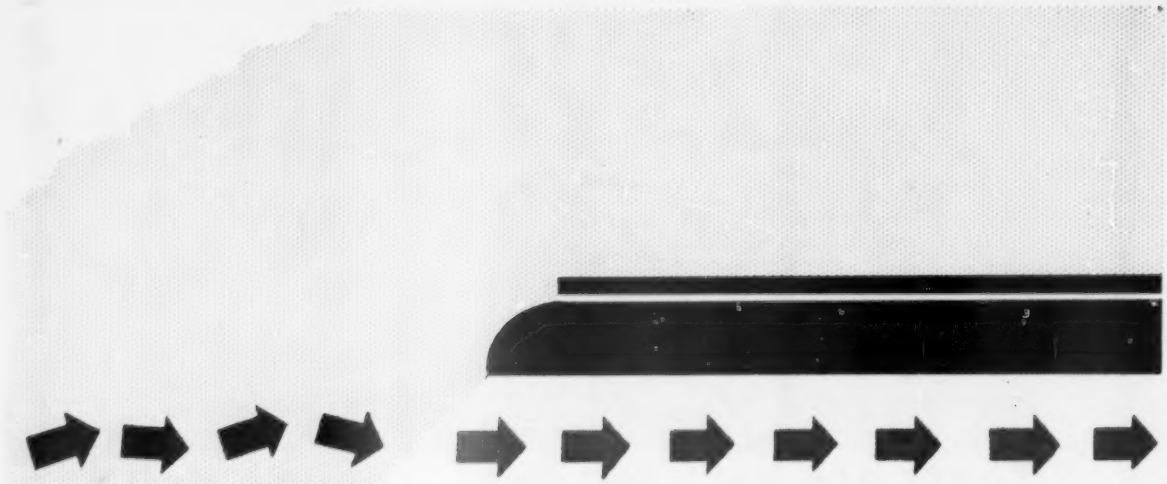


Kirkstall Bright Steel Bars

Kirkstall Forge

Engineering Limited

LEEDS 5, YORKSHIRE · TELEPHONE: HORSFORTH 2821



Better Lighting—
Better Production

What is the lighting in your factory like? Have you recently checked the lighting level round the works with a light meter?

The *right* lighting has a significant effect on the speed and accuracy of production. When its strength, position and type is suitable for each job the craftsman can give full play to his skill, and the works engineer can do full justice to his shop.

Good lighting is only one of the many ways in which electricity is playing a vital part in the drive for higher productivity.

Electricity for Productivity

Ask your ELECTRICITY BOARD for advice and information, or get in touch with E.D.A. They can lend you, without charge, films about the uses of electricity in industry. E.D.A. are also publishing a series of books on Electricity and Productivity. Titles now available are: Electric Motors and Controls, Higher Production, Lighting in Industry, Materials Handling, and Resistance Heating. Price 8/6, or 9/- post free.

Issued by the
British Electrical Development Association
2 Savoy Hill, London, W.C.2

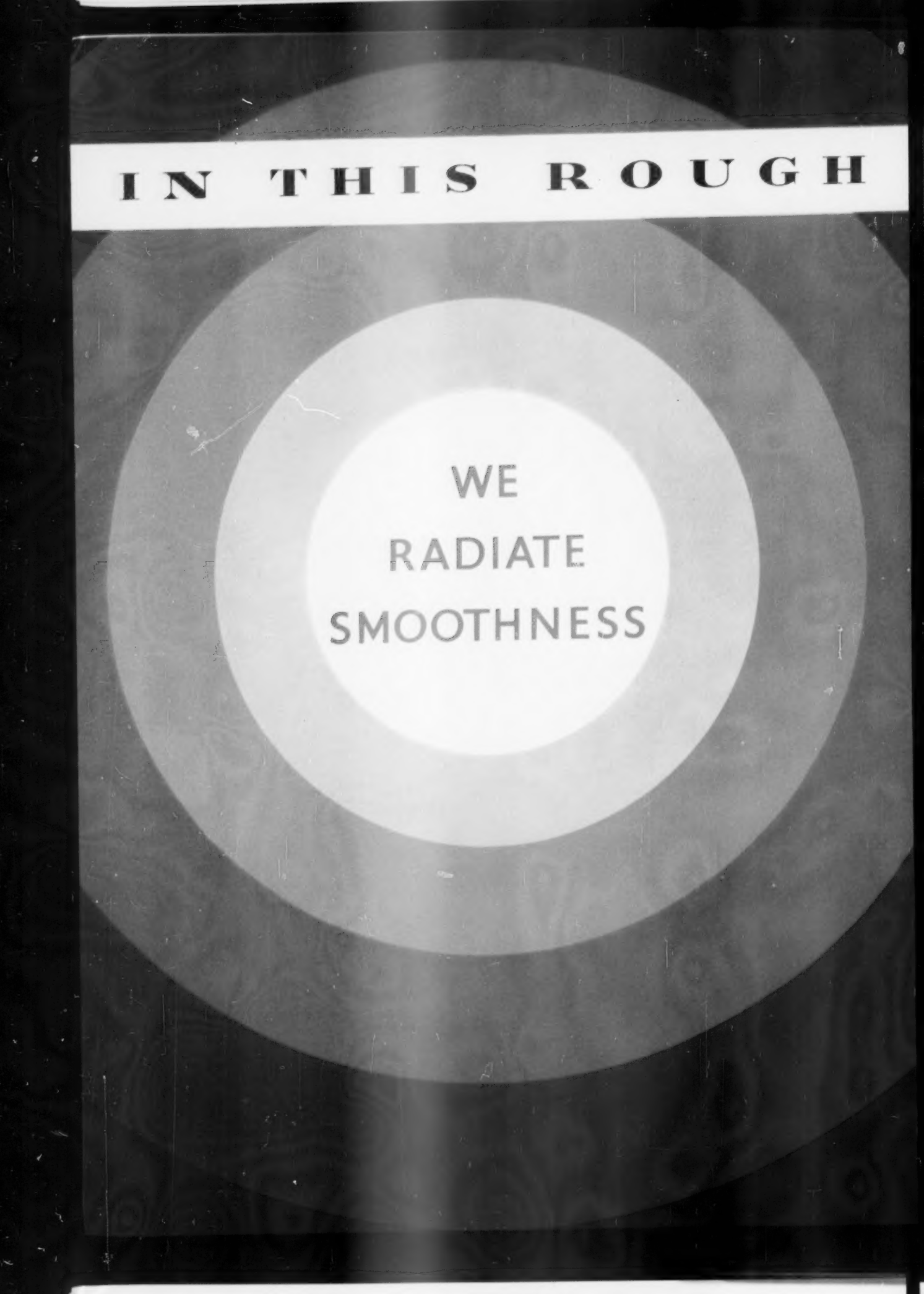
OAKENSTRONG
OAKENCORK

OIL and PETROL
GASKET MATERIALS

DISTRIBUTORS OF MATERIAL
IN BULK FOR GT. BRITAIN
J.A.NORDBERG LTD
171 QUEEN VICTORIA ST.,
LONDON,
E.C4.
Tel: Central 9678

REGISTERED
TRADE MARK

FOREIGN & COLONIAL
ENQUIRIES TO
H.JACKSON LTD
OAKENCLOUGH, CARSTANG
Nr. PRESTON
LANCS.
Tel: Garstang 8


IN THIS ROUGH
WE
RADIATE
SMOOTHNESS

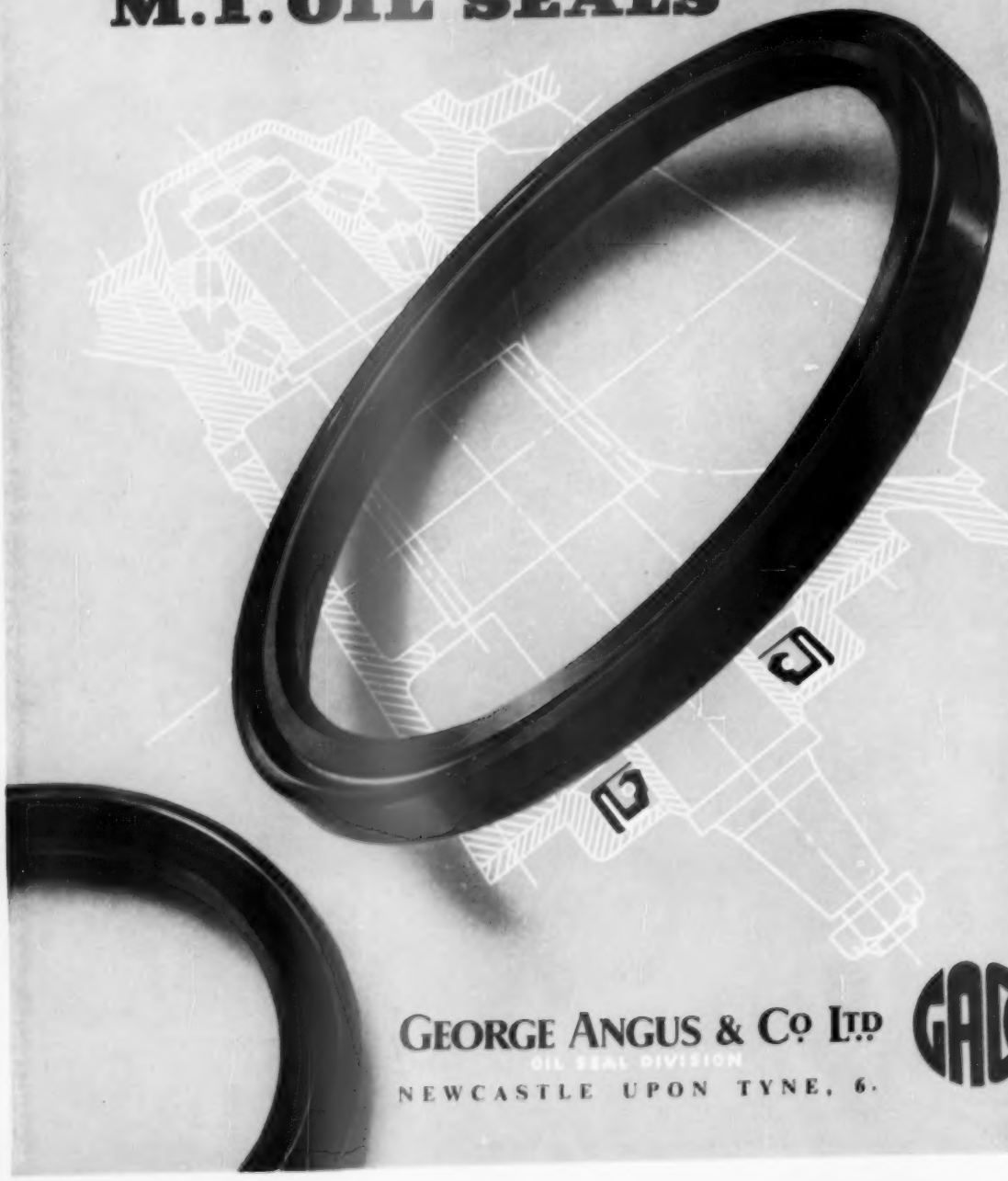
WORLD

METALASTIK

METALASTIK LTD., LEICESTER

GACO

M.I. OIL SEALS



GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
NEWCASTLE UPON TYNE, 6.

GACO

794 MILES AT 34½ M.P.G. WITH LAYCOCK OVERDRIVE ON VANGUARD III

R.A.C. OBSERVED

A TESTING ROUTE!

The congested traffic conditions along much of the A1 route is another factor making the 34½ m.p.g. figure for the 794-mile journey remarkably favourable.

and without "coasting"—a characteristic entirely absent from the Laycock Positive Overdrive

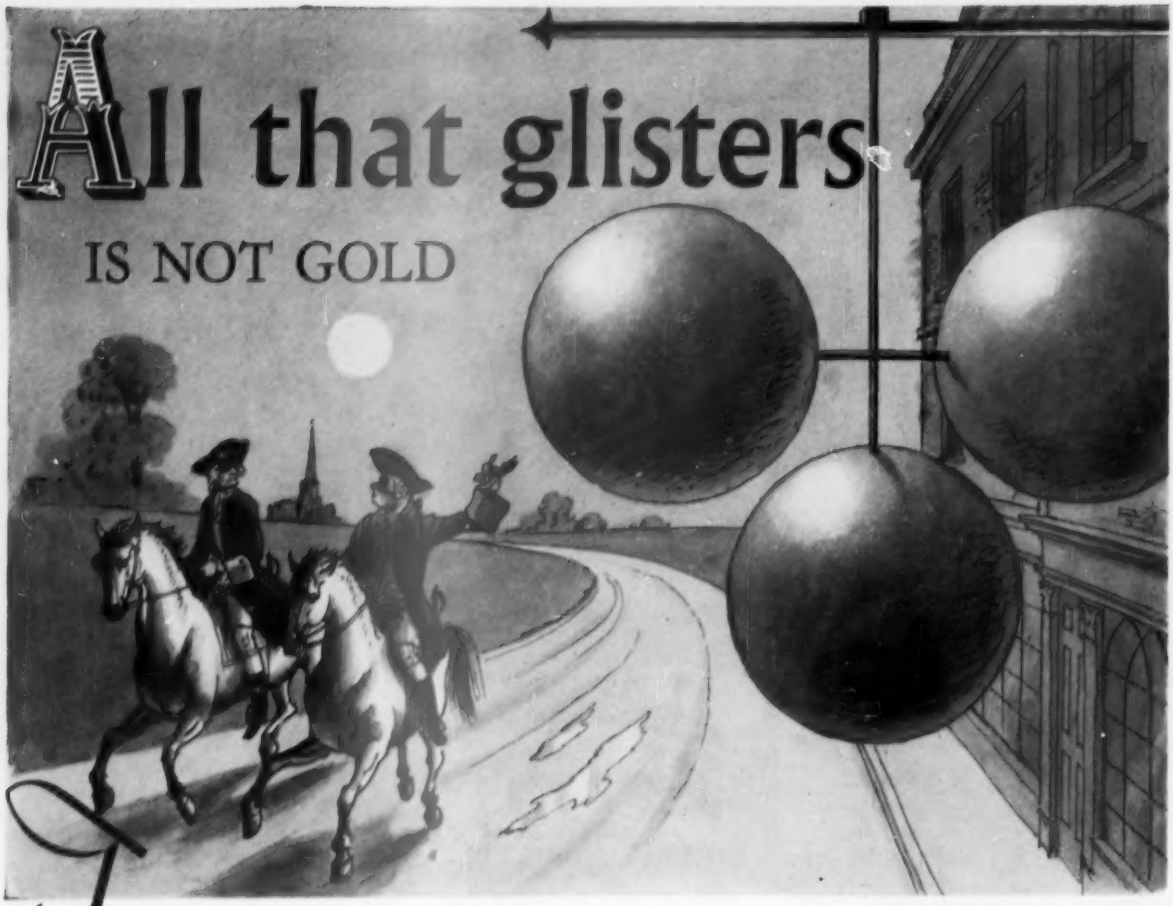
A normal Standard Vanguard III Saloon, chosen at random and fully run-in, recently gave remarkable proof of the fuel-saving possible with the Laycock de Normanville Overdrive. The Vanguard, fully laden, covered the testing 794-mile London-Edinburgh-London route at an average of 37.5 m.p.h. for a fuel consumption of only 34.53 m.p.g. The car was driven normally with appropriate use of the Overdrive and "coasting" was not permitted. Disconcerting "coasting" is in fact not possible with the *Laycock* Overdrive, the car is always under COMPLETE DRIVER CONTROL; this, in addition to its fuel-saving and other advantages, is why the All-British Laycock Overdrive is now available on 30 of Britain's finer cars.

now available on 30 British cars . . .

Laycock
(LAYCOCK DE NORMANVILLE)
Positive
Overdrive

LAYCOCK ENGINEERING LIMITED • SHEFFIELD

Enquiries to: Laycock Engineering Limited, Overdrive and Transmission Sales Division, Westminster Bank Chambers, 16/17 Hertford Street, Coventry



THREE GREAT golden balls glistened in the moonlight. "Zounds!" cried the First Robber —" there's as pretty a sight as ever I did see, all set out werry neat and orderly, and all a-ready for the taking of by two enterprising gents with an eye to business. Do you give me a leg, Skipper, and I'll part 'em from their moorings werry brisklike — afore ye can say Jack Ketch!"

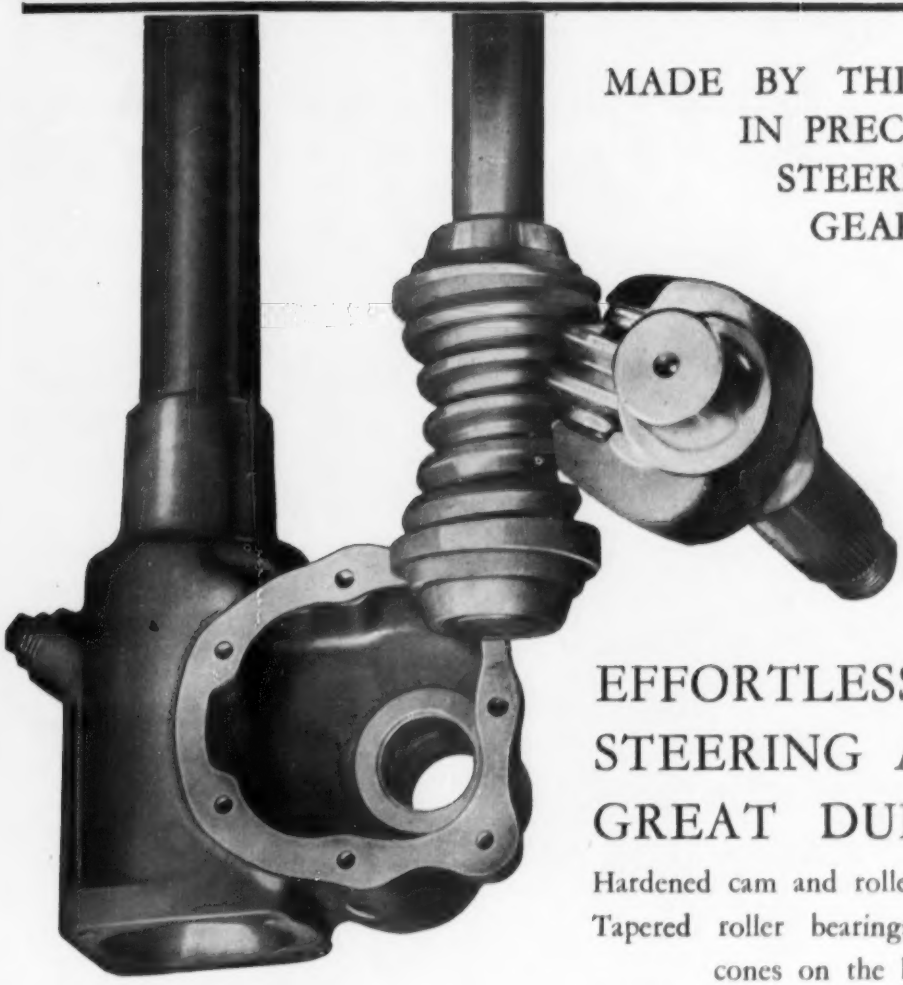
"Tch!" murmured his companion, a man of sharper intellect and wider experience than honest Jeremy — "such simple faith is sadly misplaced, old friend. These globes are neither gold nor other precious metal, being wrought — probably in Birmingham — of brass. Hollow at that —" he added testily, rapping one of them with his cane. It gave out a dull, lack-lustre note.

Jeremy frowned. "Werry misleading and unethical," he muttered, "It's them sort of things from what man's ingratitood springs." He paused, pleasingly fuddled by his little rhyme.

"Speaking of springs," said the Captain darkly, and sounding suspiciously like an advertisement, "there's *another* bone of contention in this imperfect world. Did you know that the cheapest of springs may look every bit as good as the finest quality spring, specially designed and made for ultra-high performance? And, like the three golden balls, it's only when you come to try 'em out that you find you've been conducted up the garden path. Truly 'All that glisters is not gold'! Which reminds me, I really must redeem Lord Hartlebury's timepiece..."

Advertiser's Announcement

M-W.421



MADE BY THE PIONEERS
IN PRECISION
STEERING
GEARS

EFFORTLESS STEERING AND GREAT DURABILITY

Hardened cam and roller.
Tapered roller bearings (with detachable cones on the larger sizes).
Double bearing support to rocker shaft.
End-location adjustable.
Larger angular movement.
Very compact box.
For fore-and-aft or transverse layout.
Trunnion or spigot mounting alternative on heavy types.

THE 'MARLES' DOUBLE-ROLLER GEAR, made in a range of sizes covering every type of chassis.

BETTER ROADS
FOR
BETTER LIVING

MARLES

ADAMANT
ENGINEERING CO. LTD., DALLOW ROAD, LUTON
Sole proprietors of the Marles Steering Company Ltd.
Telephone: LUTON 2662 (4 lines). *Telegrams: ADAMANT, PHONE, LUTON*

Take us fishing, Dad!

...we can't damage

the car upholstery

It's made with

GEON PVC

Yesterday—when boy met dog—seat covers met disaster. There was always a threat from old bones, scratches, mud, grease or just plain high-spirited demolition.

Today—you can specify leathercloth made with Geon PVC. As more and more manufacturers are discovering, PVC leathercloth completely satisfies their requirements and increases customer satisfaction.

Please write for descriptive booklet No. 116 free on request.

Everflex PVC leathercloth by Bernard Wardle used as car upholstery material at the Coventry factory of Carbodies Ltd.

LEATHERCLOTH MADE WITH GEON PVC

Will not scratch

Sponges clean in a stroke

Resists heavy wear

Is impervious to stains

BRITISH GEON LIMITED

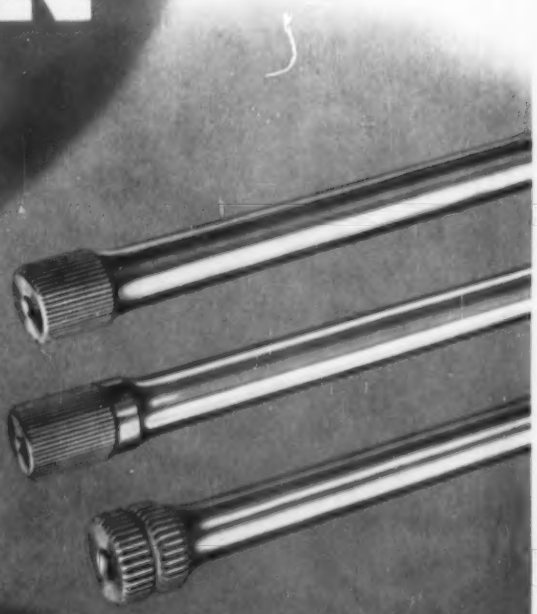
Geon Polyvinyl Materials

Sales and Technical Service

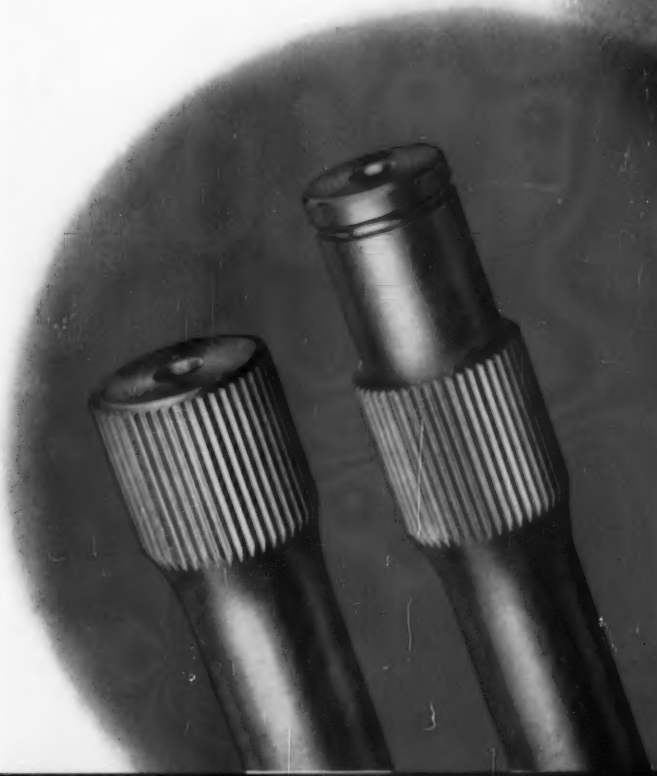
DEVONSHIRE HOUSE PICCADILLY LONDON W1 TELEPHONE MAYFAIR 8867

TOLEDO WOODHEAD SPRINGS LTD.

TORSION BARS



Toledo Woodhead Splined Torsion Bars are being supplied to several famous vehicle manufacturers, and our new plant has capacity to supply more. May we have your enquiries?



WE ARE ALSO THE MANUFACTURERS OF

KANTLINK

SPRING WASHERS

TOLEDO WOODHEAD SPRINGS LIMITED SHEFFIELD 3

TWS 47

service!

*200,000 miles and only ·010" wear

with a

* *Only after 200,000 miles of hard going, on a Canadian Dodge fitted with a Perkins P6 oil unit, was a Don-Flex DF/66F Clutch Disc removed for inspection. It was found to be in excellent condition and good for many thousand more miles. Wear was only .010 in.!*

PATENT NONSCORING FLEXIBLE

Don-Flex

CLUTCH DISC

. . . and for safety in stopping—

Don **Molded and Woven Brake Liners** *of course!*

We shall be happy to supply full details and technical information on request

A Nation-wide chain of depots to serve you

BELFAST *28967*
BIRMINGHAM 5 *Midland 4659*
BLACKBURN *6581*
BRISTOL *27214*
CARDIFF *27026*
CARLISLE *21589*
CHESTER *21280*
COVENTRY *64914*
DUNDEE *1728*
EDINBURGH 1 *Central 4234*
GLASGOW C2 *Central 4594*
HARROGATE *67058*
HULL *Central 52072*
IPSWICH *3025*
LEEDS 3 *20664/5*
LEYTON *Leytonstone 6068*
LIVERPOOL *Royal 3202 and 1351*
MANCHESTER 3 *Blackfriars 0596*
NEWCASTLE-ON-TYNE 2 *27142 and 27942*
NOTTINGHAM *43646*
SHEFFIELD 1 *25529*
SOUTHAMPTON *21276*
STOKE-ON-TRENT *44021*
WIMBLEDON *4248/9*
Republic of Ireland:
DUBLIN, 35 Westland Row *66597 and 66518*

SMALL & PARKES LTD · Hendham Vale Works · Manchester 9

LONDON: 76 Victoria Street, S.W.1

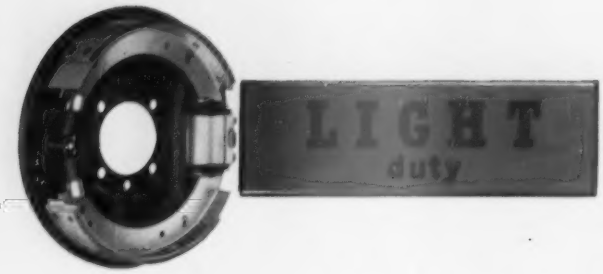
For all the best engines

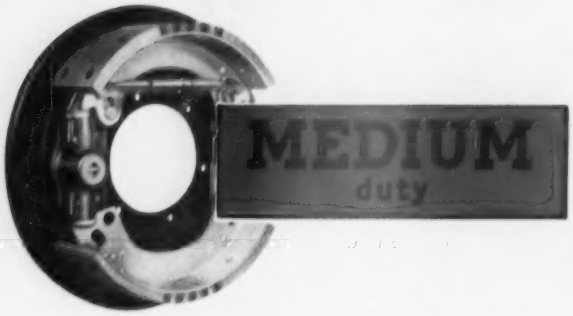
PISTONS
PISTON RINGS
CYLINDER LINERS
VALVE SEAT INSERTS
VALVE GUIDES
TAPPETS ETC.

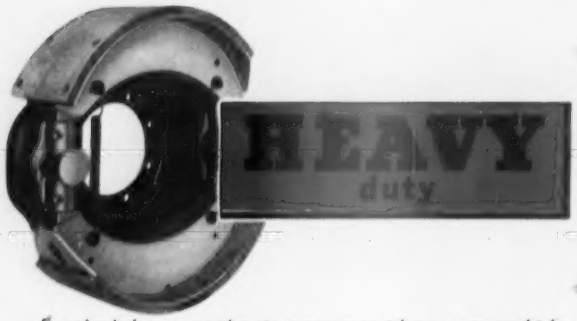
QUALITY PAYS!

THE BRITISH PISTON RING CO. LTD. HOLBROOK LANE COVENTRY

Cogent







For the baby car or the giant commercial transport vehicle, the Girling name means high efficiency brakes. Backed by unrivalled research and development facilities, Girling design and manufacture are geared to the production of equipment specifically designed for a specific job. For every type of motor vehicle, Girling Brakes are performing daily with the utmost reliability, always strengthening the proud claim . . .

GIRLING

THE BEST BRAKES IN THE WORLD

GIRLING LIMITED
KINGS ROAD
BIRMINGHAM 11

WAY OUT AHEAD

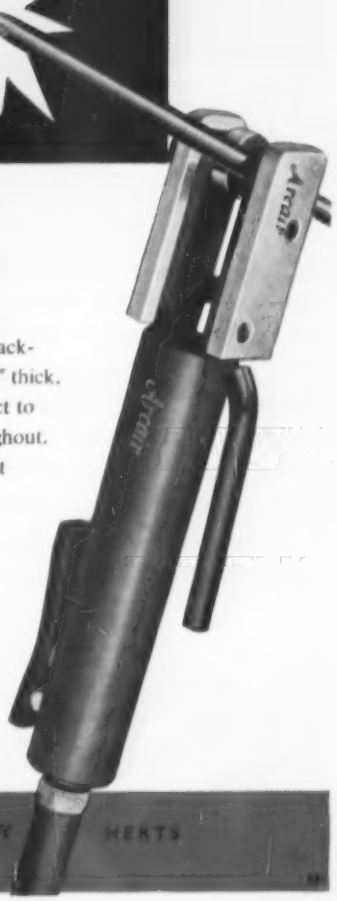
Arcair FOR ESSO!

(PATENTED)

FOSTER WHEELER LTD fabricates further extensions to Esso's gigantic Oil Refinery at Fawley, Southampton

Fabrication of the REACTOR, part of the new HYDROFORMER unit being built by FOSTER WHEELER LTD. for the ESSO PETROLEUM CO., LTD. The ARCAIR Torch is being used to back-gouge the outside welds, prior to welding the inside seams. The shell plates of this vessel are 2¼" thick. Construction must meet the stringent requirements of the A.P.I.A.S.M.E. code and is subject to 100% X-Ray inspection. Lincoln machines and Fleetweld 5 electrodes are being used throughout.

The Arcair Torch saves on cutting and gouging up to 80%! This new patent complete unit uses only electric arc and compressed air. Air-cooled for operating-comfort, with self-aligning rotating jet for adjusting carbons to all angles. Melts *any* metal by electric arc, then dissipates the molten metal by continuous high-velocity compressed air. Special Arcair copper-coated graphite carbons, in 7 sizes, are used.



Arcair CUTS COSTS!

Write for full information to sole European manufacturers and distributors, Dept. U

LINCOLN ELECTRIC CO LTD · WELWYN GARDEN CITY · HERTS
WELWYN GARDEN 928

All according to plan

The hydraulic governor is a complete vindication of the methods used by C.A.V. technicians. They set out to find the ideal governor for the high speed diesel engine—one which would give improved idling and excellent response to the accelerator, and yet was adaptable to meet the requirements of engines of many types. Above all, this unit had to be capable of giving years of trouble-free service.

Such a problem was not to be solved at the first attempt. It necessitated years of patient research, planning and development, of testing followed by redesign, until a unit was evolved which appeared to fulfil all requirements.

But now came the crucial test. How wou'd the production governors stand up to the rigours of modern transport conditions? The target set was a quarter of a million miles. To-day, many hydraulic governors on C.A.V. 'N' type pumps have exceeded this mileage. One unit recently examined had, in fact, covered 400,000 miles without any attention; it was functioning as well as when new and required no maintenance before being returned to service

Get to know the C.A.V. HYDRAULIC GOVERNOR

C.A.V.

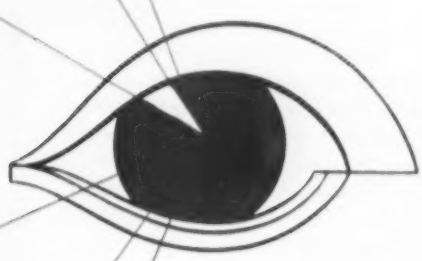
The World's Leading Manufacturers of

FUEL INJECTION EQUIPMENT

C.A.V. LIMITED, ACTON, LONDON, W.3

AP174-777

from every point of view –



– far better tools

DRILLS

ENGINEERS' AND SAW FILES

MILLED TOOTH FILES

HACKSAW BLADES

SCREW THREAD TOOLS OF ALL TYPES

REAMERS

ENGINEERS' CUTTING TOOLS OF ALL TYPES

F. H. T.

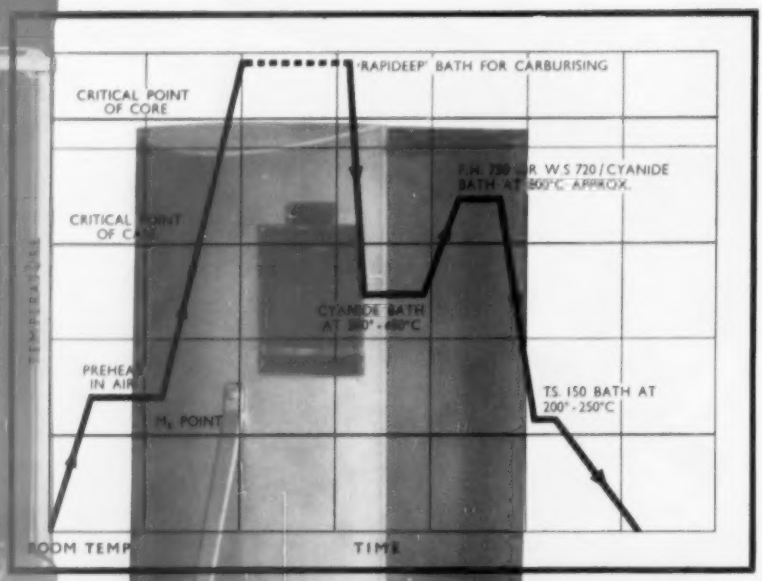
FIRTH BROWN TOOLS LTD

SPEEDICUT WORKS, CARLISLE STREET EAST,

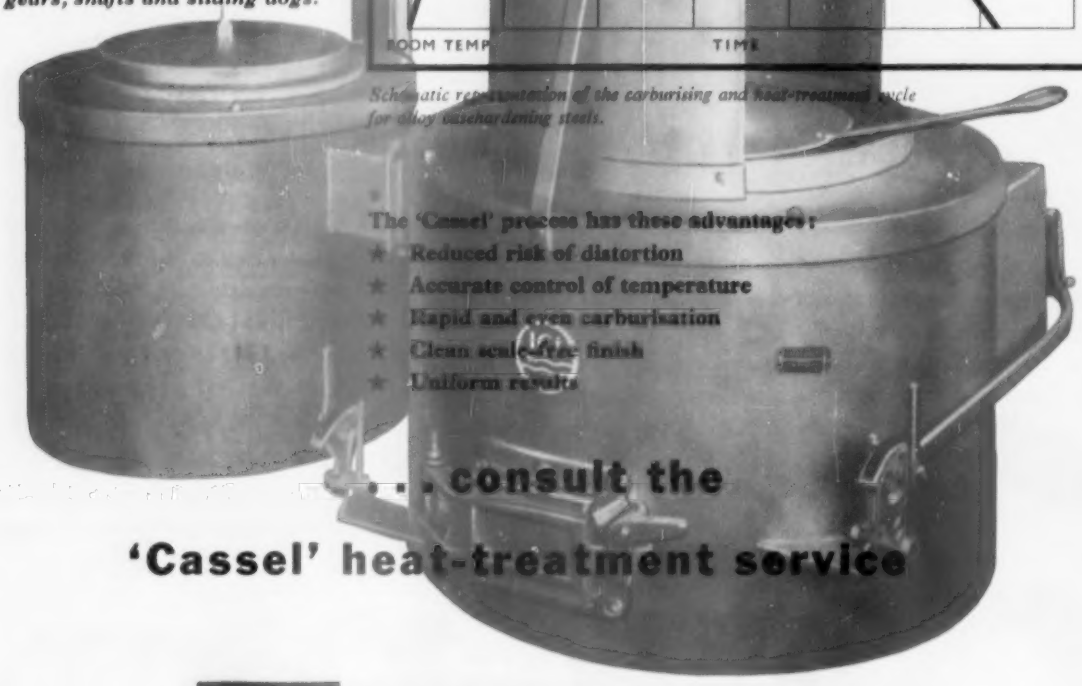
SHEFFIELD ENGLAND

for casehardening heat-treatment brazing . . .

The 'Cassel' Heat-Treatment Service offers a complete range of salts, furnaces and technical advisory facilities to meet all problems. For instance, considerable reduction in distortion during casehardening of alloy steel gears can be effected by a complete treatment cycle in salt baths, including carburising and martempering. This is, in part, due to the even heating possible in salt but also because the steel passes through the range of martensite formation only once during this casehardening process. The method is being applied on a production scale to gears, shafts and sliding dogs.



Schematic representation of the carburising and heat-treatment cycle for alloy casehardening steels.



The 'Cassel' process has these advantages:

- ★ **Reduced risk of distortion**
- ★ **Accurate control of temperature**
- ★ **Rapid and even carburisation**
- ★ **Clean scale-free finish**
- ★ **Uniform results**

. . . consult the 'Cassel' heat-treatment service

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1

CC.172

Proved in Service

Largest in the David Brown range, the 557 CM 5-speed Gearbox has proved itself as a completely dependable unit by the large numbers giving world wide trouble-free service, often under really tough operating conditions.

Outstanding features include:—

- **Constant mesh gears for all speeds including reverse, ensuring long life and quiet running.**
- **Alternative standard ratios giving direct or over-drive top gear**
- **Sturdy, simple and compact design, having low weight to strength ratio.**
- **Gear shafts located in horizontal plane, permitting shallow case.**
- **Upper half can be removed without disturbing gears or selector mechanism.**
- **Compact forward control unit, connected to gearbox by two universal joints offering flexibility of chassis layout.**

Specification E.393.19, giving complete details, is available on request.

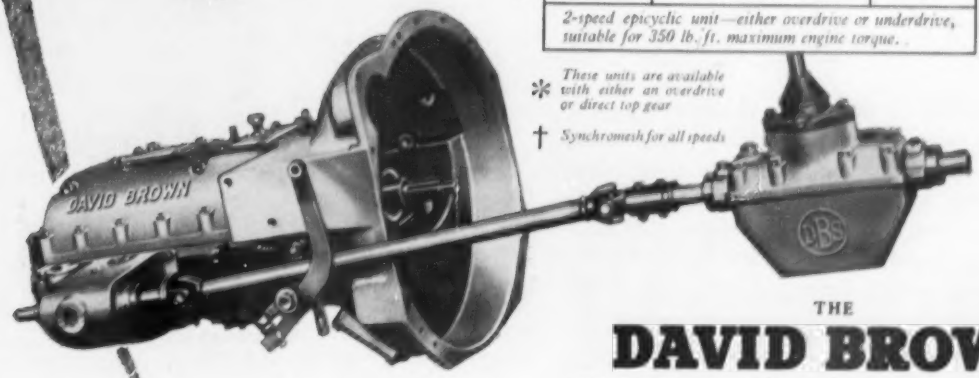
STANDARD GEARBOX RANGE

	Type	Max. Engine Torque (lb/ft)	No. of Speeds
	430C	90	4
	437	133	4
✲	542	205	5
✲	45	250	5
✲	045	250	5
†	S450	300	4
✲	557CM	350	5

2-speed epicyclic unit—either overdrive or underdrive, suitable for 350 lb./ft. maximum engine torque.

✲ *These units are available with either an overdrive or direct top gear*

† *Synchromesh for all speeds*



THE

DAVID BROWN

CORPORATION (SALES) LIMITED

AUTOMOBILE GEARBOX DIVISION

PARK WORKS HUDDERSFIELD

Lloyds Ductile Iron

has a greater tensile strength than some steels with the castability and machineability of iron

GRADE	Ultimate Tensile Stress Tons/sq. in.	Yield Stress Tons/sq. in.	Elongation % (on 2 in.)	Transverse Rupture Stress Tons/sq. in.	Compression Strength Tons/sq. in.	Impact Izod. 10 mm. sq. notched ft. lb.	Brinell Hardness
PEARLITIC — —	35–45	25–35	1–5	55–65	65–80	4	230/280
PEARLITIC/FERRITIC	32 min.	24 min.	5 min.				
FERRITIC — —	27/35	20/25	10/25	55/60	48/58	12	140/180

With Lloyds Ductile Iron, the graphite flakes common to ordinary cast iron are present in the form of spheroids. It can be cast as accurately and as easily as ordinary cast iron, but compared with flake-graphite iron is stronger, tougher and ductile.

Lloyds Ductile Iron is now being used for a wide range of engineering parts and in some instances is replacing cast or forged steels, malleable iron and non-ferrous metals. It also replaces grey iron, permitting reduced section thickness to take advantage of the better properties offered and it may well enable you to re-design your present castings for more efficiency.

The successful casting of Ductile Iron demands the strictest and most experienced metallurgical and melting control, but Lloyds have been casting it daily, continuously since 1950! Technical advice freely given on request.

CYLINDER BODY in Ductile Iron. Weight 30 lbs. Cast for Baguely Ltd.

TRANSMISSION BEARING in Ductile Iron. Weight 30 lbs. Cast for Hawthorn Davey Ltd.

Lloyds of Burton

Ductile Iron is only one of the range of High Duty Irons cast by Lloyds

LLOYDS (BURTON) LTD., WELLINGTON WORKS, BURTON-ON-TRENT · TELEPHONE: BURTON 3867

The Bristol "Britannia" *(Photograph by permission of The Bristol Aeroplane Co. Ltd.)*

TORRINGTON NEEDLE BEARINGS

provide sensitivity of control

The low coefficient of friction – both in starting and running – made the Torrington Needle Bearing an ideal choice for the aileron controls of the "Britannia."

Unlike a plain bearing which has a fairly high starting coefficient of friction, the Needle Bearing needs no more push to "get it going" than to "keep it going."

Nor are the frictional characteristics of the Needle Bearing dependent upon maintaining a continuous oil film as in plain bearings.

This all adds up to inexpensive and simpler designs with higher efficiency and dependability.

Let our Bearings Division advise you on your anti-friction problems.

THE TORRINGTON COMPANY LTD. *Works:* Torrington Avenue, Coventry
London Office: 7-10 Eldon Street, EC2 *Glasgow Office:* 14 Moir Street, C1

These features make the **TORRINGTON NEEDLE BEARING** *unique*

- ★ *Low coefficient of starting and running friction*
- ★ *Full complement of rollers*
- ★ *Unequalled radial load capacity*
- ★ *Low unit cost*
- ★ *Long service life*
- ★ *Compactness and light weight*
- ★ *Runs directly on hardened shafts*
- ★ *Permits larger and stiffer shafts*

TORRINGTON *NEEDLE* **BEARINGS**

NOW AVAILABLE FROM OUR ENGLISH FACTORY

ΦAA

Seals of Authority

Henry VIII

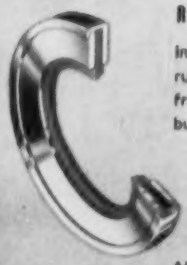
Henry VIII (1491-1547) was the first English Monarch to be educated under the influence of the Renaissance. Although, perhaps, better known for the fact that he had six wives and was responsible for the dissolution of the Monasteries, he was nevertheless an accomplished scholar, linguist, musician, and athlete and had a passion for efficiency and for the greatness of England and himself.

"ROMET" FACE TYPE SEALS

For all water pump and similar applications.

RECIPROCATING SEALS ("C" & "U" RINGS)

For all types of hydraulic and pneumatic applications.



ROTARY SHAFT SEALS

In leather and synthetic rubber for all requirements from ¼" up to 36" shaft: in built-up type or bonded.

FACE TYPE SEALS

For arduous duty. Suitable for bogie wheels and idler wheels for track vehicles.

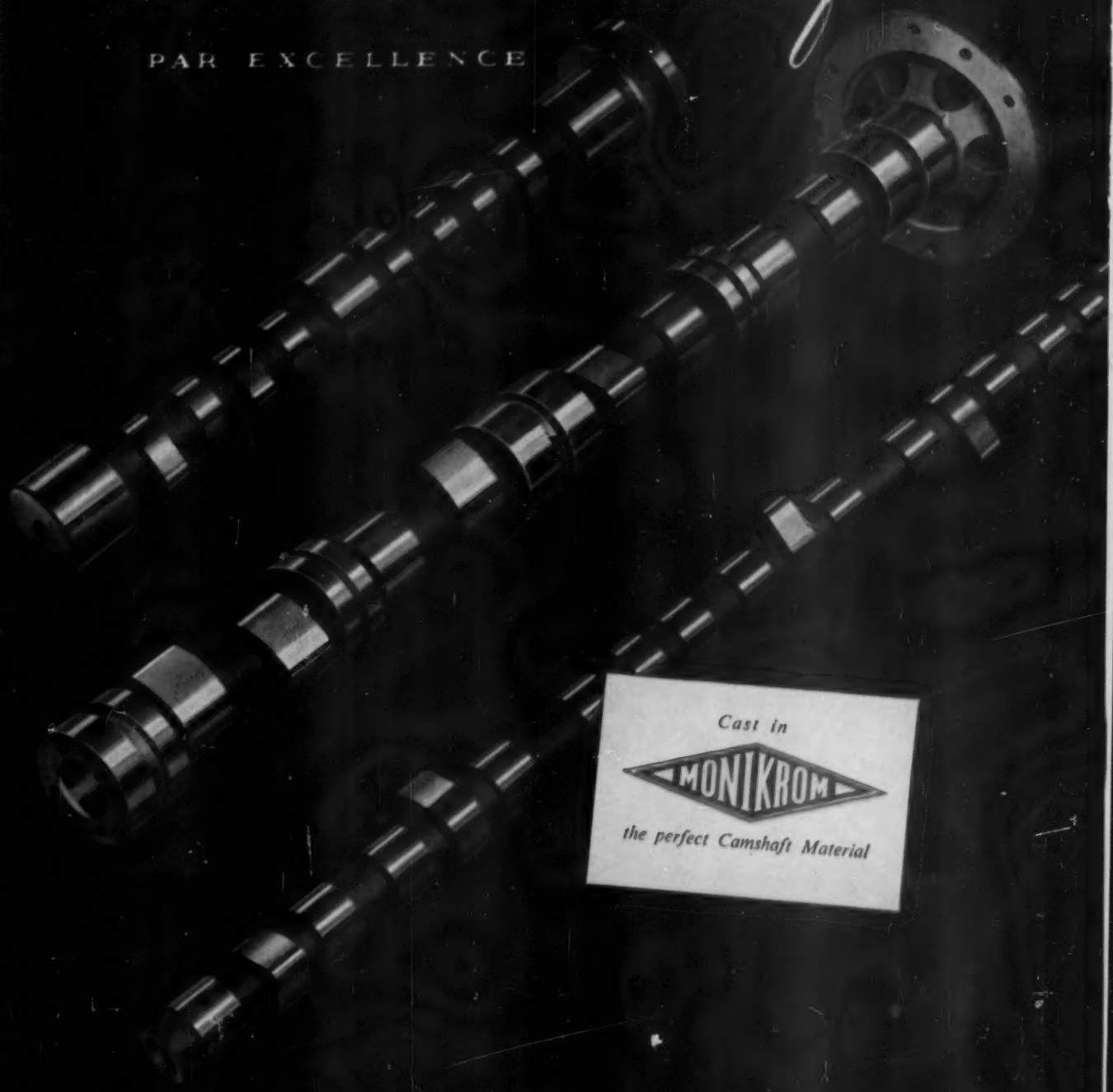
All types of seals are made to customers own requirements. Our technical representatives will be pleased to call and discuss your problems.

The Authority on Seals

SUPER OIL SEALS & GASKETS LTD., Factory Centre, Birmingham, 30

Moulded Camshafts

PAR EXCELLENCE



Cast in

MONIKROM

the perfect Camshaft Material

MIDCYL

THE MIDLAND MOTOR CYLINDER CO. LTD., SMETHWICK, STAFFS.

OBTURATION

You came down that hill quiet . . . lost your bottom gear?

No—came down in third.

Go on! What's the secret?

Obturation—got that from the leaflet. Means bunging up the exhaust pipe; makes the engine work as a compressor like—slows the truck through the transmission. Dead steady.

Sounds alright. Feel safe?

Not 'arf. I come down hills like a king on his throne. Hardly touch my brakes except to stop.

Not much use to me—not many hills on my run.

Don't be daft. It's just the job in town—coming to traffic lights or corners. And it's a snip in the wet—no skids.

Cost much?

Pays for itself over and over again. The guv'nor says he saves the earth on brake linings and more than a bit on fuel.

What about my 'bus?

Fits on any diesel-engine job.

Control easy?

Dead simple; and Clayton-Dewandre—that's the firm that makes it—have a whole range of controls—manual and automatic to choose from. Ask your boss to write to them.

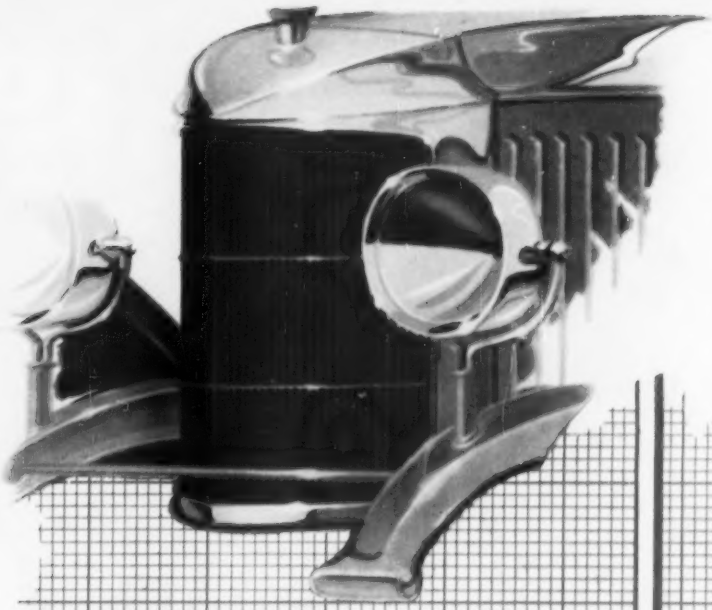
Clayton-Oetiker Exhaust Brake

THE BRAKE THAT NEVER FADES.

CLAYTON DEWANDRE LIMITED

TITANIC WORKS · LINCOLN · ENGLAND

E8.2



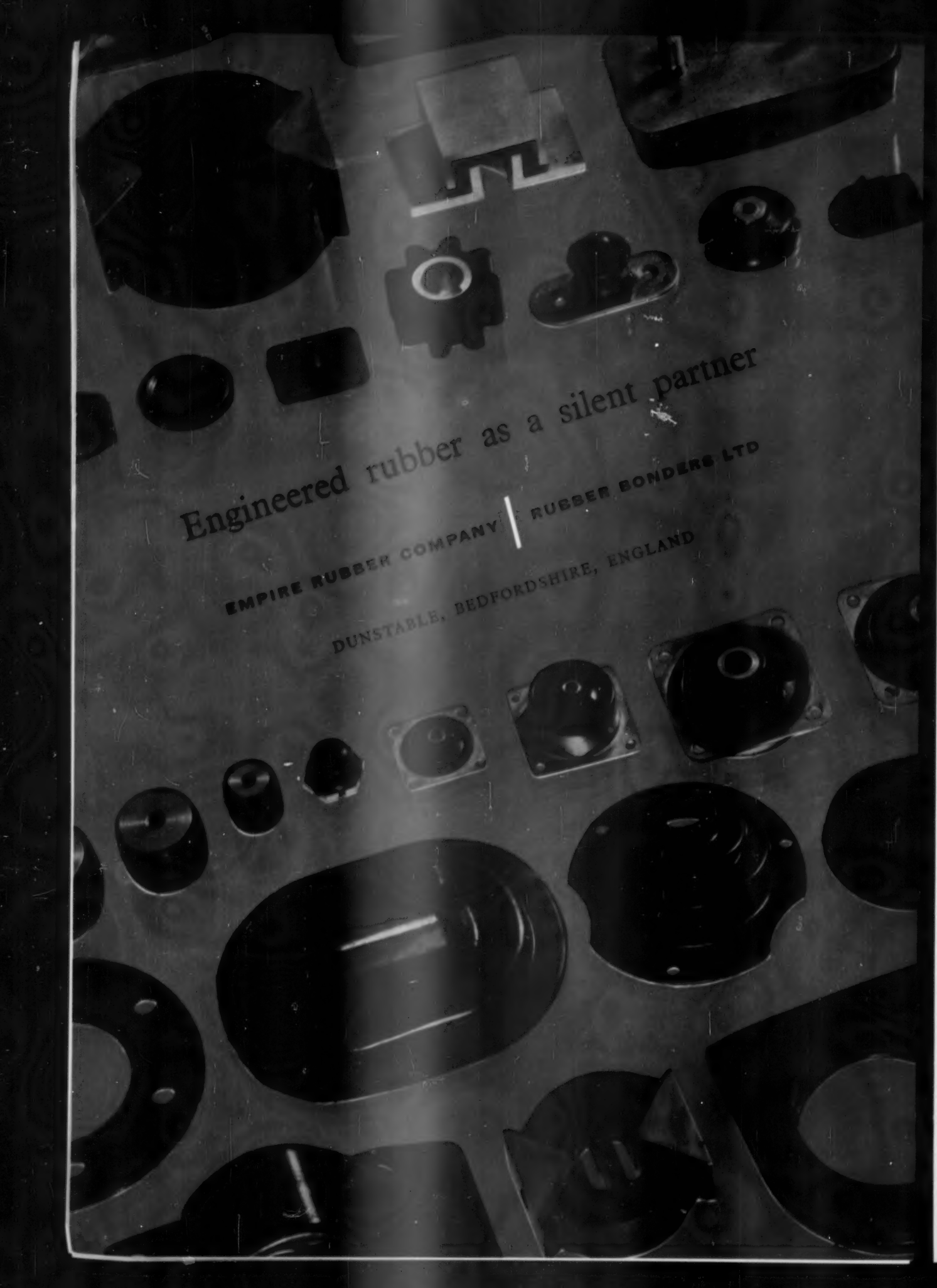
A COOL HALF CENTURY

CMF

COVENTRY MOTOR FITTINGS

COVENTRY. TEL. 3144

RADIATOR SPECIALISTS SINCE 1905


Engineered rubber as a silent partner
EMPIRE RUBBER COMPANY | RUBBER BONDERS LTD
DUNSTABLE, BEDFORDSHIRE, ENGLAND

when HOT AIR

makes good sense

Sometimes hot air makes good sense! Where heat-treatment is concerned, for instance. For here, the forced circulation of heated air provides the best available medium for tempering, secondary hardening, the heat-treatment of light alloys and non-ferrous annealing. Wild-Barfield have brought the forced air circulation furnace to the highest standard of perfection. Their furnaces permit precise control of temperature and time with simplicity of operation and maintenance. They will be glad to supply further information and make recommendations to meet individual needs.

FORCED AIR CIRCULATION FURNACES

ELECTRIC WILD BARFIELD FURNACES

FOR ALL HEAT-TREATMENT PURPOSES

WILD-BARFIELD ELECTRIC FURNACES LIMITED

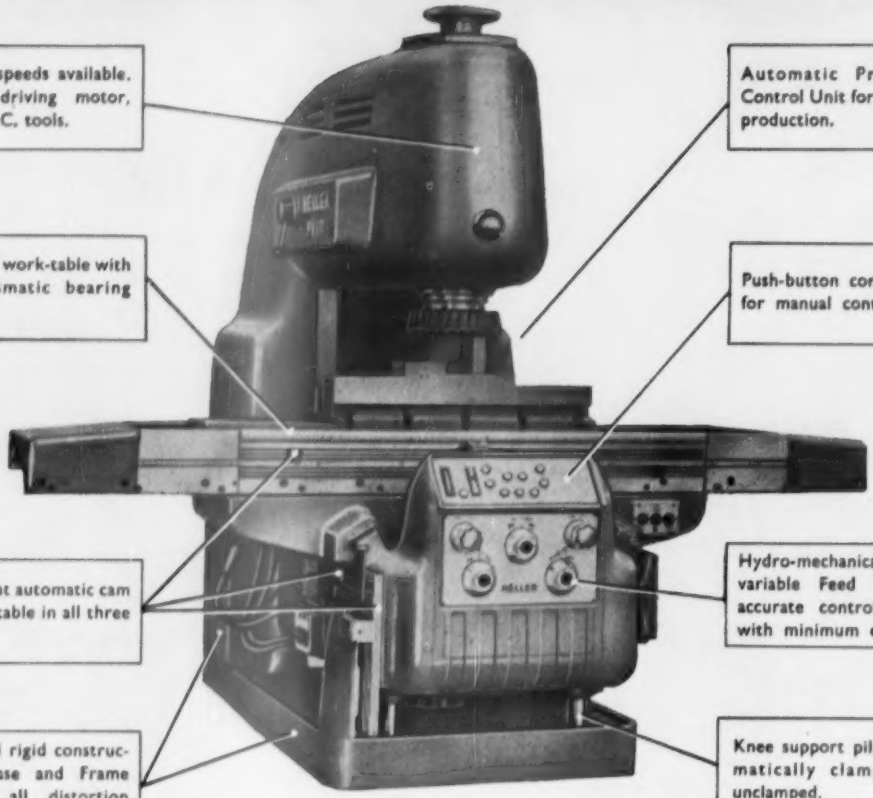
ELECFURN WORKS, OTTERSPOOL WAY, WATFORD BY-PASS, WATFORD, HERTS. Telephone: Watford 6091 (8 lines).

WB 18

HELLER

TYPES 120-2 & 160

A range of milling machines with all the features you've ever wanted



16 cutter speeds available. Powerful driving motor, ideal for T.C. tools.

Automatic Programme Control Unit for repetition production.

Large rigid work-table with wide prismatic bearing surfaces.

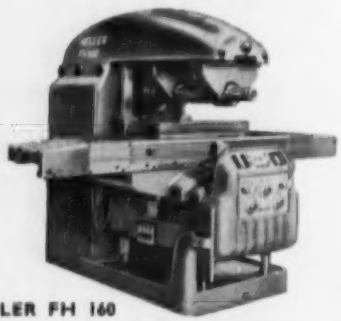
Push-button control panel for manual control.

Independent automatic cam control of table in all three directions.

Hydro-mechanical infinitely variable Feed Drive for accurate control of feed with minimum effort.

Robust and rigid construction of Base and Frame eliminates all distortion and vibration.

Knee support pillars automatically clamped and unclamped.



HELLER FH 160

Whether your production is concerned with repetition milling, batch milling, or heavy milling of individual components, here is a range of new milling machines which will interest you.

For repetition work, the operator has only to load the machine and start the automatic work cycle, which will exactly and automatically repeat all the feed movements pre-set on it.

Profile milling of batch quantities can also be carried out without operator attention, the Electro-Hydraulic Tracer Control Unit copying from a template or model in two dimensions with extreme accuracy.

Heavy milling of individual components is facilitated by the push-button control panel; this enables the operator to work within the finest limits at a high rate of production.

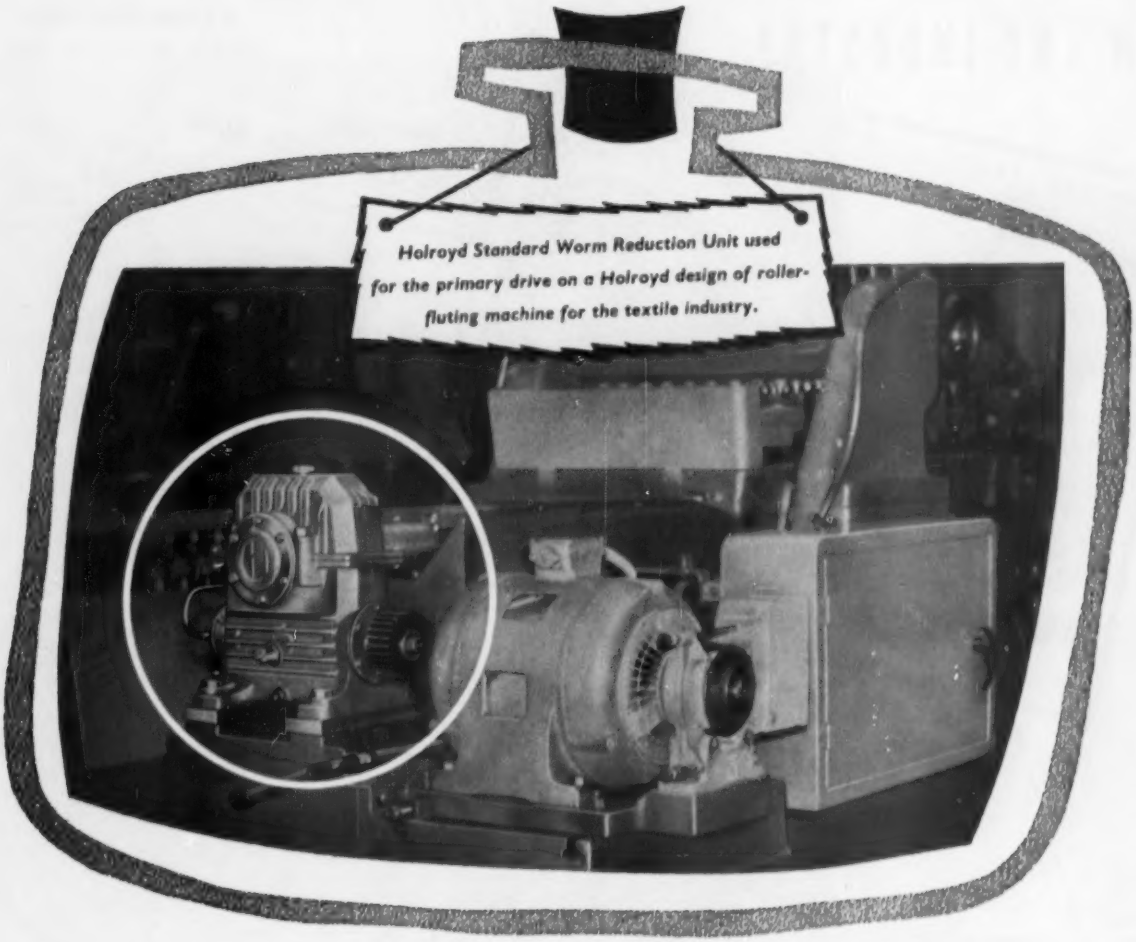
Write for a catalogue to-day.

WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

Telephone: Coventry 40351

398F82


Holroyd Standard Worm Reduction Unit used for the primary drive on a Holroyd design of roller-fluting machine for the textile industry.

Taking our own medicine

We read one of our own advertisements the other day and it bucked us up no end. We felt so proud of our own Worm Reduction Units we decided to use one for the primary drive on a roller-fluting machine we've been designing for the textile industry. And of course it worked a treat. Just what you'd expect from a Holroyd Worm Unit—with a prescription of special metals, rigorous testing and 50 years' experience.

MADE UP FOR YOU QUICKLY

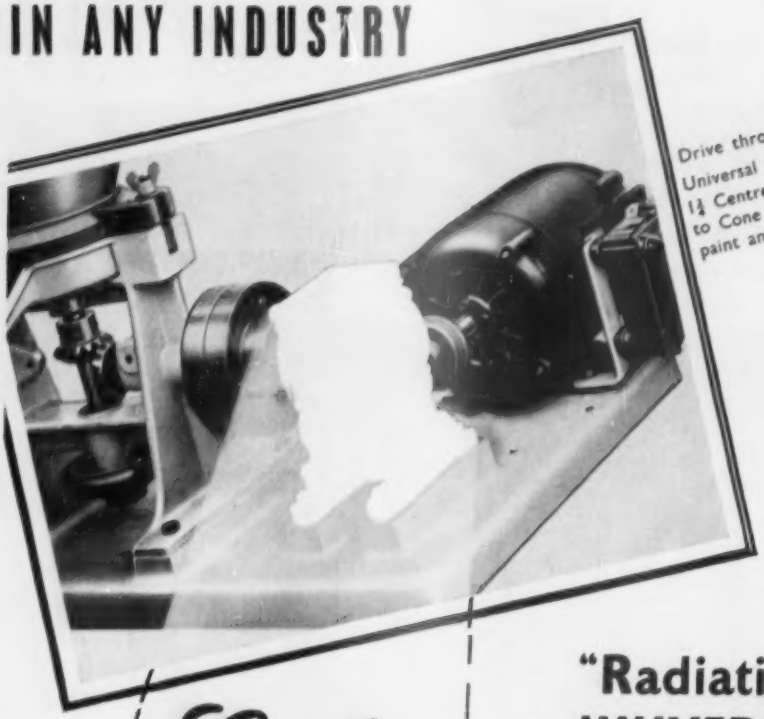
A Standard Type Holroyd Worm Reduction Unit with a stock ratio can be made up, packed and despatched to you fairly quickly. Worms, wheels and special units made to order take somewhat longer. For information on our Worm Units and their applications drop us a line at Milnrow, Lancs. We'll be glad to help you all we can.

Holroyd WORM REDUCTION UNITS

JOHN HOLROYD & COMPANY LIMITED · MILNROW · LANCS · TELEPHONE: MILNROW 55388

CHC173

IN ANY INDUSTRY



Drive through Crofts Universal Mounting Worm Gear, 1½ Centres and Flexible Coupling, to Cone Grinding Mill for paint and ink trade.

ALTERNATIVE FOOT MOUNTING POSITIONS

Crofts

"Radiation" UNIVERSAL MOUNTING WORM REDUCTION GEARS COMPLETE THE PICTURE

The ideal Worm Reducer for small power applications up to 2½ H.P. Ratios 5 - 1 up to 60 - 1. Standard, Vertical & Inverted units FROM STOCK. Adaptable for every possible mounting position.

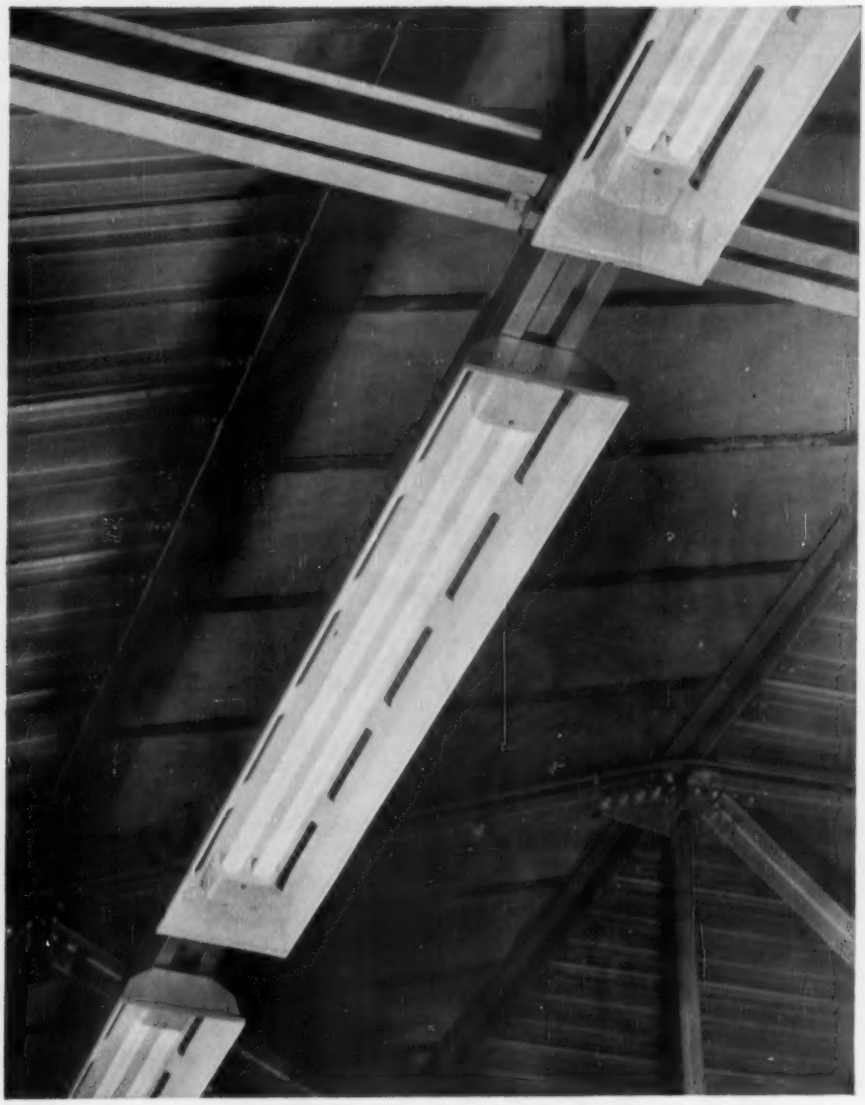
For details see Pub. No. 532/1

POST FOR YOUR COPY ***NOW!***

Crofts (ENGINEERS) LIMITED. BRADFORD 3. ENGLAND

PHONE 65251 (15 LINES) GRAMS :- "CROFTERS BRADFORD"

182



You'll be glad it's . . .

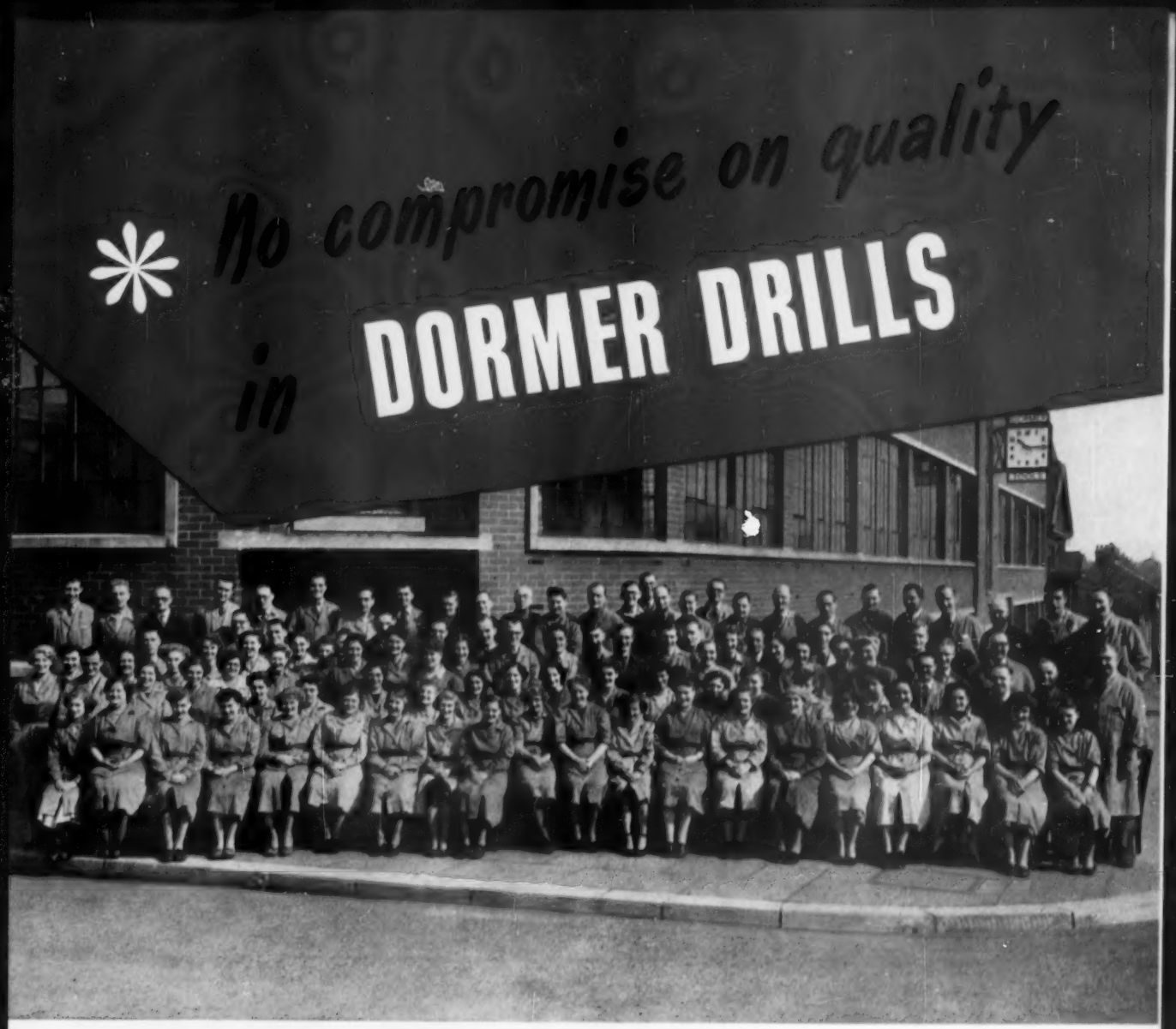
- *G.E.C. continuous lighting trunking is the ideal system for large area fluorescent lighting.*
- *Installation costs are considerably lower than equivalent schemes using individually suspended units with conduit tubing.*
- *Various types of reflectors are available. Different reflectors may be used on the same trunking run. They can be positioned anywhere along the trunking and may be moved without any additional drilling.*
- *Consult the G.E.C. Lighting Advisory Service through your contractor for the most suitable lighting trunking system . . . with OSRAM tubes, of course.*

G.E.C.

The General Electric Co. Ltd,
Magnet House, Kingsway, London WC2

Tested daily in a single private fleet of nearly 1,000 vehicles

Shell-Mex & B.P. Ltd. run the largest privately owned fleet of commercial vehicles in Britain. 70% are diesel-engined. They all use Shell DERV or BP DERV. These products therefore undergo a huge-scale daily test. If they were anything less than completely satisfactory, we should be the first to know—and the first to suffer. For all operators of diesel-engined vehicles this vast consumption is the finest possible guarantee of our faith in the products we market—the finest possible assurance that no shortcoming, however slight, could escape our notice.



130 INSPECTORS *see to that!*

WORKING UNDER IDEAL CONDITIONS OUR INSPECTION STAFF CHECK EVERY FEATURE OF EACH DORMER DRILL. THIS STAFF ENSURE THERE NEED BE NO LIMIT TO YOUR CONFIDENCE IN

DORMER

THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED

SHEFFIELD ENGLAND

DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

C. P. Newall & Co., Ltd.

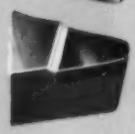
POSSILPARK GLASGOW · N

Wimet – Britain's first carbide tools

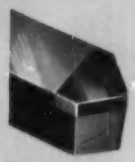
Way back in 1927 Wickman introduced carbide tools to this country. Since that time their use has spread so widely among the metal-working industries that to-day the name 'Wimet' has become synonymous with carbide tools and the higher productivity they bring. And with good reason; they cut faster, last longer, maintain accuracy and reduce tooling costs.

Here's today's range of standard turning tools available from stock

STRAIGHT ROUND NOSE TURNING TOOLS
For light-duty turning work, boring, chamfering, or profile turning.

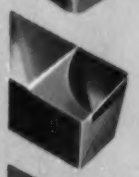


CRANKED ROUND NOSE TURNING TOOLS
For light cuts, plain turning and facing.



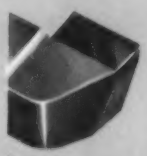
TURNING OR BORING TOOLS
For light-duty turning and boring.

HEAVY-DUTY TURNING AND FACING TOOLS
For very heavy turning, boring and facing operations.

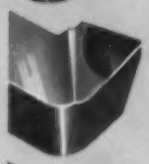


BAR TURNING TOOLS
For plain turning to square shoulders, recessing and counter boring.

BAR TURNING TOOLS
Suitable for use in knee holders.
For bar roughing, heavy boring and heavy turning, facing, etc.

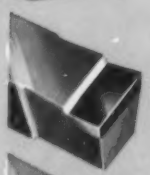


CRANKED KNIFE TOOLS
For broad facing cuts or similar operations.



CRANKED TURNING TOOLS
For light-duty turning and facing, boring and turning to square shoulders, etc.

CRANKED TURNING AND FACING TOOLS
For heavy-duty plain turning, facing, chamfering, boring, etc.



RECESSING TOOLS
For plunge cut recessing with light feeds and heavy-duty parting off.

PARTING TOOLS
Made in two types; one for high cutting pressures, the other for light duty on all materials.

CLAMPTIP TOOLS
Available with round, triangular or square inserts.

An unsurpassed record!

The very first Wickman carbide tool was supplied to Armstrong Siddeley Motors Ltd., in August 1927. This tool remained in regular service until March, 1932. Four-and-a-half years' use from a single tool.

3 small books dealing with the application and re-servicing of carbide tools can help operators and production engineers. Write for copies now.

THE WIMET MANUAL contains full details of all Wimet Standard Tools—it's the buyer's guide for carbide tools. If you use carbide tools write to The Publicity Dept., Wickman Ltd., for a copy.

WICKMAN *of* COVENTRY

WICKMAN LIMITED, WIMET DIVISION, TORRINGTON AVENUE
COVENTRY, ENGLAND. *Telephone: Tile Hill 66621*

Wickman

3405T

Close limit forging...

Close limit forging of a compressor blade at the Works of Omes Limited, Barnes, S.W.13. ("The Aeroplane" copyright photograph).

..with MoS_2

Omes Limited, specialists in precision stampings for the automobile and aircraft industries, have been regular and enthusiastic users of **'dag'** dispersions for many years.

Recently Omes tested **'dag'** Product 1126 (colloidal molybdenum disulphide in white spirit) as a die lubricant for the close limit forging of compressor blades in stainless steel. Needless to say, all close tolerance working demands absolute cleanliness of the die surface: a loose hair of a brush would ruin the forging. Choice of lubricant and method of application are therefore of vital importance, and for these reasons Omes use a 'dag' dispersion and apply it by spray instead of brush. Both lubricant and method are highly satisfactory. "The blades", writes the firm's Development Manager, "are successfully and consistently forged to the close tolerances required". He goes on to say that 'dag' Product 1126 has proved **superior to any type of lubricant previously used for close limit forging.** Longer die life and much improved surface finish have resulted.

We believe this tribute from a firm of Omes' standing deserves your attention. If you agree, we shall be pleased to tell you more about the use of molybdenum disulphide for forging.

ACHESON COLLOIDS LIMITED
18, PALL MALL, LONDON, S.W.1.

Telephone : WHI 2034-9.
Telegrams : OILDAG - PICCY - LONDON.
Also ACHESON COLLOIDS COMPANY,
Port Huron, Michigan, U.S.A.

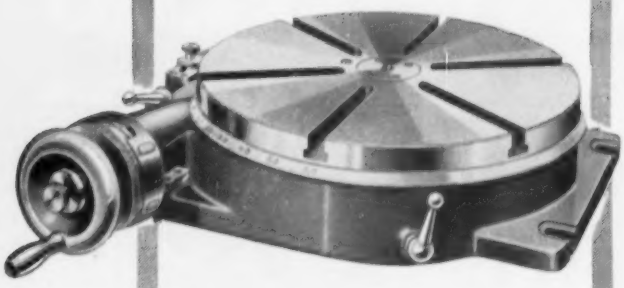
Colloidal dispersions of graphite, molybdenum disulphide and other solids, in oil, water and volatile solvents for every industrial requirement.
Please write for literature.

dag
REGD TRADE MARK
DISPERSIONS

1126/AC.59

Only the best castings for MATRIX

COVENTRY GAUGE & TOOL COMPANY LTD



Harper quality covers grey iron and Meehanite castings, shell moulding and ductile iron, also metal pressings, machining, enamelling and other finishes and sub-assembly work.

For their 12" Rotary Table, Coventry Gauge & Tool Co. Ltd. say they specify Harper Castings "because they are always of a uniform quality, homogeneous in structure and have a first-class finish." The excellent machining properties of Harper Castings help to maintain the quality and accuracy of the Matrix Rotary Table — a valuable piece of equipment for use on small jig boring machines and light milling machines.

HARPER CASTINGS

JOHN HARPER & CO. LTD. JOHN HARPER (MEEHANITE) LTD.
ALBION WORKS Phone: WILLENHALL 124 (5 lines) Grams: HARPERS, WILLENHALL **WILLENHALL**

LONDON OFFICE: SEAFORTH PLACE, 57, BUCKINGHAM GATE, LONDON S.W.1 Tel.: TATE GALLERY 0286

CASTINGS WITH THE HARPER SEAL

H519

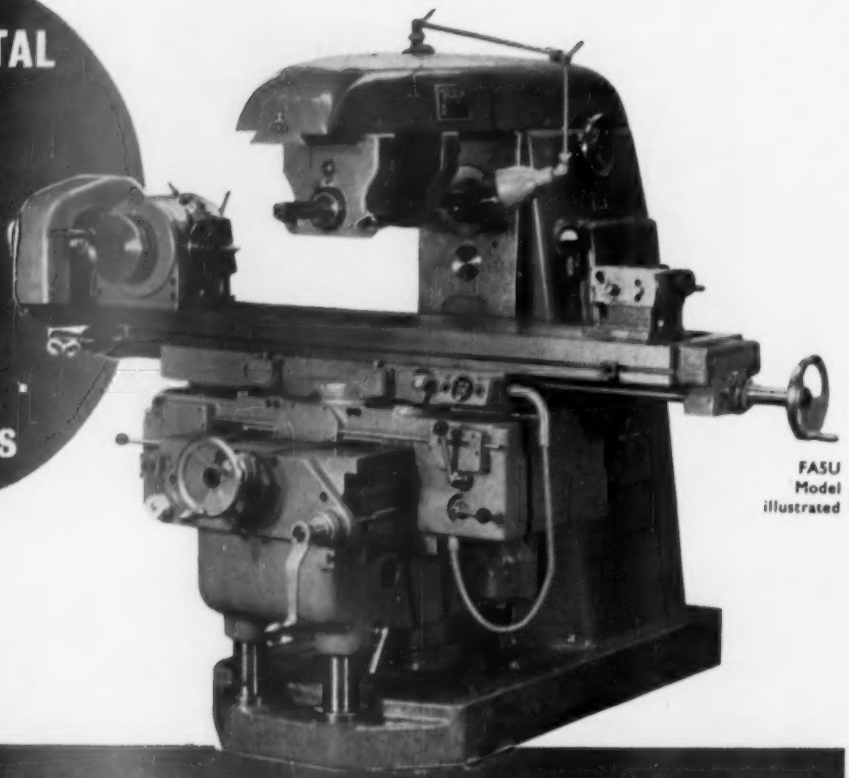
HORIZONTAL

UNIVERSAL

VERTICAL

All sizes . . .

. . all types



FA5U Model illustrated

ZBROJOVKA MILLERS

Early delivery of all models from London stock

BRIEF SPECIFICATIONS				
FOUR SIZES	No. 2	No. 3	No. 4	No. 5
Working surface of table (approx.)	40" x 8"	50" x 10"	64" x 12"	80" x 16"
Power longitudinal travel (approx.)	25"	32"	40"	50"
Power cross travel (approx.)	8"	9"	12"	16"
Spindle Speeds	63-2800	45-2000	32-1400	18-1400

SOLE AGENT

Selson MACHINE TOOLS

The Selson Machine Tool Co. Ltd

CUNARD WORKS, CHASE ROAD, NORTH ACTON, LONDON, N.W.10

Telephone: Elgar 4000 (10 lines) Telegrams: Selsomachi, London

THE 600 GROUP

KIRKSTALL AXLES

FOR
MOBILE CRANES

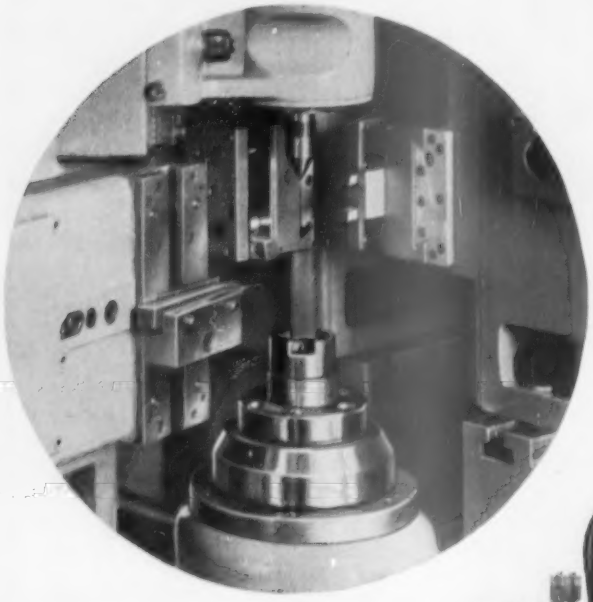
KIRKSTALL FORGE ENGINEERING LIMITED
LEEDS, 5

Telephone: Horsforth 2821

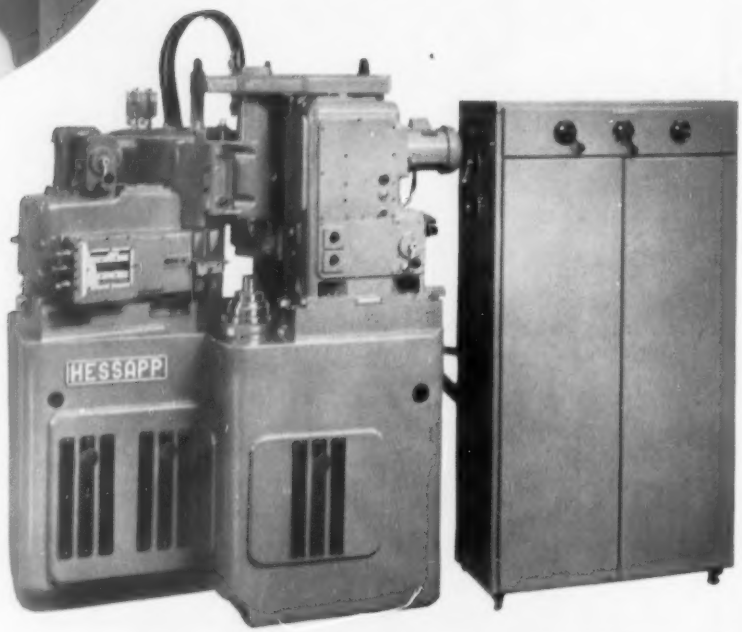
Automatic cycle for turning to precision accuracy with highest surface finish . . . .

HESSAPP

Vertical Spindle FINE TURNING MACHINE . . .



- *Can be arranged with two Vertical and two Horizontal multi tool slides.*
- *Covered Vernier Scales for precision setting of slides.*
- *Air or hydraulic clamping of workpiece and tailstock by push button control.*



- Speeds infinitely variable 300-3,000 r.p.m. Feeds ·0002″—·010″ per rev.
- Maximum turning length of each vertical slide 4·13″.
- Maximum turning depth of each horizontal slide 2·56″.
- Net Weight: 2½ tons.

Maximum diameter 4½″ Maximum length turned 8″.

Please send Component Drawings for Production Layouts and Cycle times.

Our Showrooms are only a few minutes from London Airport.

International Machine Tool Exhibition June 22nd to July 6th 1956
Olympia, London
Grand Hall
Stand Nos. 45 & 61

Sole Selling Agents

ELGAR
Machine Tool Company Limited

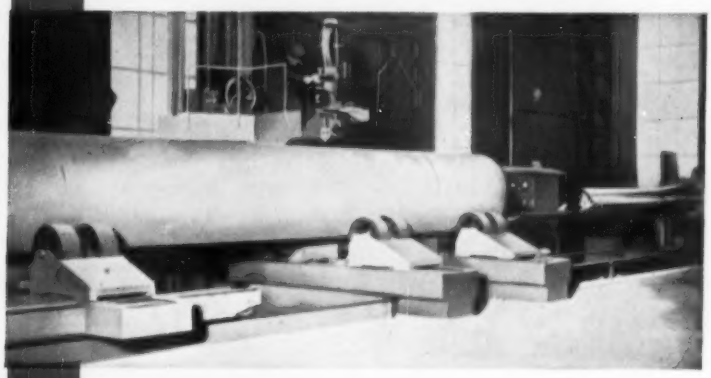
HAMPTON ROAD WEST · HANWORTH · FELTHAM · MIDDLESEX
Phone : FELTHAM 4266 Cables & Grams : SHIPMENTS, FELTHAM

When it comes to WELDING

Automatic Welding?

We sell the whole works

As the biggest and most experienced people in automatic arc welding, Quasi-Arc Limited offer the Production Engineer advantages he can get nowhere else. They are ready to supply him promptly with *everything he needs*—plant, welding materials, expert service—all from one old-established and reliable firm.



External and internal welding of Class 1 boiler drums, by the Fusarc process. Note the versatile cantilever—supported automatic welding head; boom-type internal welder (right) with effective welding traverse of 15′ 0″; and the adjustable motorised roller bed, working in conjunction with an idler-bed unit. All manufactured, installed and serviced by Quasi-Arc Limited—and only one of many complex automatic welding installations now in production.

Continuous Welding Processes

Quasi-Arc are the only people who make and sell *two* continuous automatic arc welding processes—Fusarc and Unionmelt, with all their present-day variations.

Fusarc

The biggest-selling continuous covered electrode process in the world—and in its field the most economical. Fusarc with its visible arc, runs fast and efficiently, and gives excellent results both indoors and outdoors.

Unionmelt

The world-renowned submerged arc process, giving X-ray sound welds with perfect finish. There is no spatter and no flash. It is rapidly expanding into light plate welding as well as in heavy fabrication work.

Welding Manipulators

Quasi-Arc supply a wide variety of manipulative equipment from manipulators and positioners to roller bed units. They are built on years of experience and development and can be incorporated with any welding process in complete automatic welding installations.

The interests and activities of The Quasi-Arc Company Limited and Fusarc Limited in the well-known processes

Quasi-Arc · Fusarc · Unionmelt · Sigma · Heliarc · Twin-Arc

have been combined in order to provide a thoroughly comprehensive and effective service to the welding industry.
The headquarters of the new organisation—named Quasi-Arc Limited—are at Bilston, Staffordshire, with works at Bilston and Gateshead.

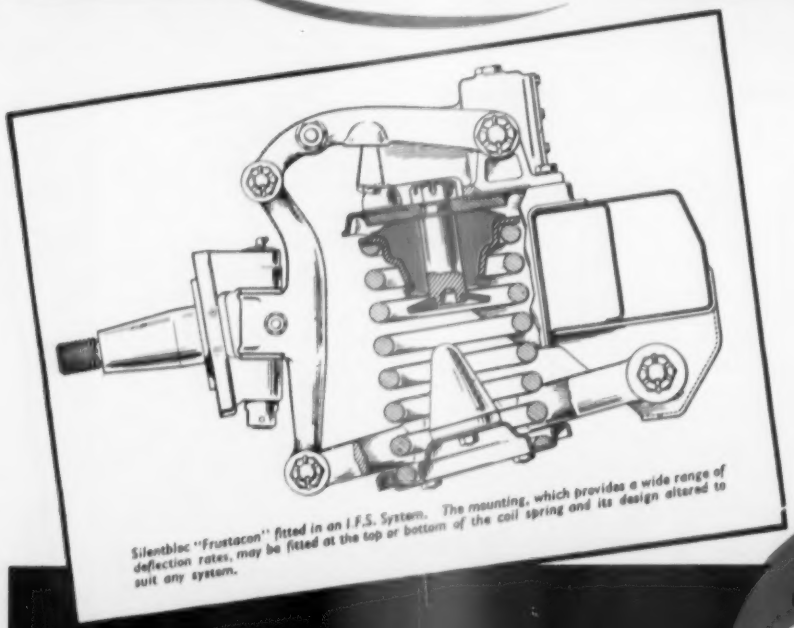
Come to QUASI-ARC

QUASI-ARC LIMITED · BILSTON · STAFFORDSHIRE

Silentbloc FRUSTACON..

. . . the first scientifically designed flexible mounting fitted to the I.F.S. of a Production Car

The 'Frustacon' mounting fitted to the I.F.S. of the 1952 Rover '75'. Sectioned to show rubber.



Silentbloc "Frustacon" fitted in an I.F.S. System. The mounting, which provides a wide range of deflection rates, may be fitted at the top or bottom of the coil spring and its design altered to suit any system.

To minimise the transmission of road noise to the body by the coil springs, Silentbloc Frustacon mountings have been incorporated in the I.F.S. of the 1952 Rover '75'. This notable step forward in the reduction of noise is another example of co-operation between car manufacturers and Silentbloc Ltd.

DESIGNERS AND MANUFACTURERS OF RESILIENT UNITS FOR MORE THAN 25 YEARS

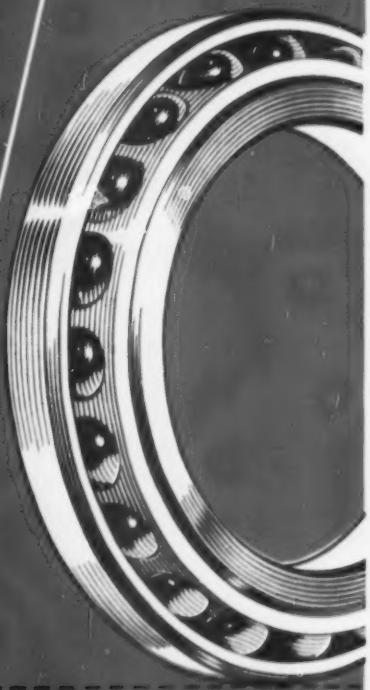
SILENTBLOC LTD.

MANOR ROYAL, CRAWLEY, SUSSEX

Tel. Crawley 2100

for really

High Speeds



Light weight high speed cages

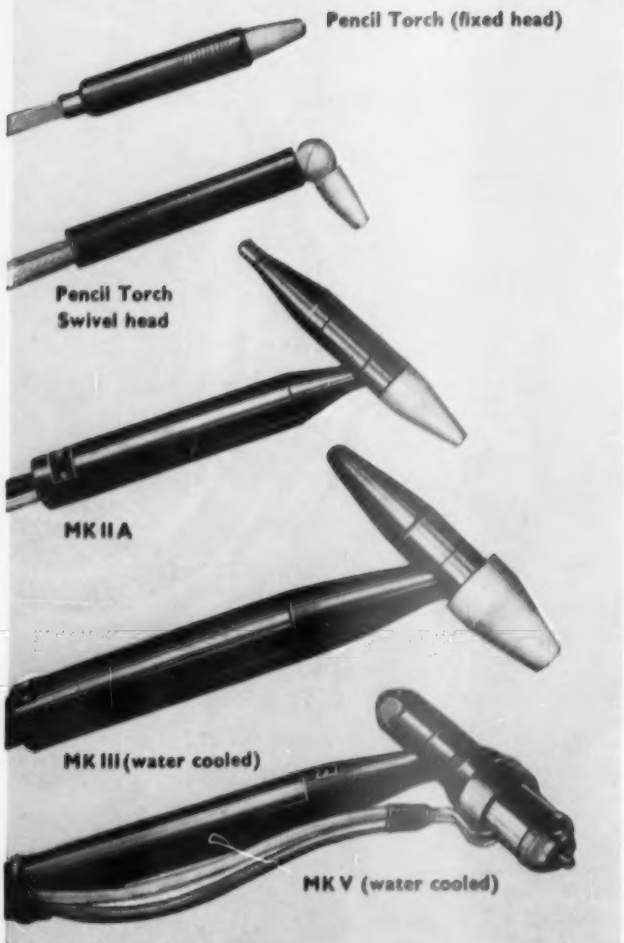
Ultra precision accuracy

Our Technical Department
will recommend a suitable bearing
for your application

R M BALL AND ROLLER BEARINGS

RANSOME & MARLES BEARING CO. LTD

NEWARK-ON-TRENT



FIVE TORCHES FOR ARGONARC WELDING

British Oxygen can supply a complete range of argonarc handwelding torches for all classes of work. Smallest of these is the Pencil Torch —specially designed for intricate work or where access is difficult. A swivel head version of this torch almost enables you to weld round corners. For welding light alloys up to 16 swg and 1″ thick respectively, there are the popular MK IIA and MK III torches; while the MK V—welding ¼″ aluminium in one pass—is most suited to heavier work.

For further details write to your nearest branch.

BOC BRITISH OXYGEN

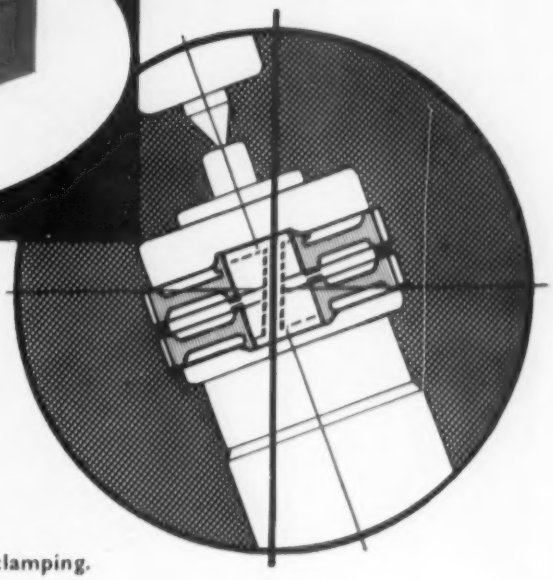
Hydrax production data

Patent No. 708767
(Foreign Patents Pending)

HELICAL GEARS

60 TEETH. 8·5 D.P.
20° HELIX ANGLE. 1½" FACE WIDTH
7·500 PITCH CIRCLE DIA.
MAT. 1 PER CENT CHROMIUM
STEEL STAMPING 45/55 TONS
TENSILE APPROX.

CUT TWO PER SETTING. USING
THREE START HOB. FINISH
SUITABLE FOR SUBSEQUENT
GRINDING OR SHAVING
OPERATIONS.
HYDRAX FLOOR TO FLOOR
TIME PER GEAR
2·25 MINS.



With its tremendous production rate, the Hydrax is the ideal gear hobbing machine for any Automation plant layout. Its output and accuracy slash the cost of both gear cutting and subsequent operations.

HYDRAX FEATURES INCLUDE:-

- Hydraulically operated quick acting work clamping.
- Automatic cutting cycle under control of one push button.
- Reduced hob travel for helicals.
- Automatic hob shift.
- No differential or lead cam.
- Automatic loading.

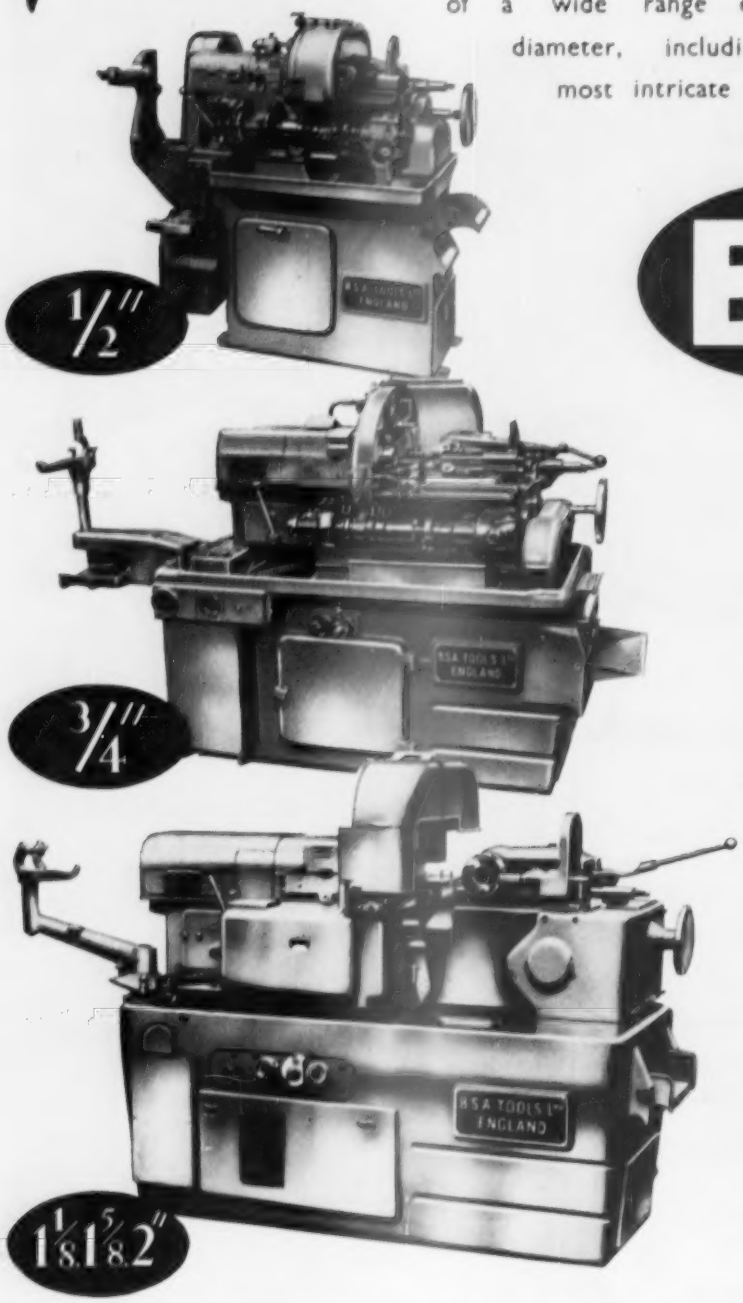
Please write for publication M.104.2.

Hydrax

THE
DAVID BROWN
CORPORATION (SALES) LIMITED
MACHINE TOOL DIVISION
BRITANNIA WORKS SHERBORNE STREET
MANCHESTER 3

for trouble-free continuous high-output

of a wide range of components up to 2 in. diameter, including those involving even the most intricate automatic machining operations



BSA

single spindle automatic screw machines

With the minimum of attention B.S.A. automatic screw machines will maintain constant production at the peak of efficiency. Every feature of their design and manufacture is a contribution to their endurance under the most strenuous conditions. Positive lubrication is assured by a refinement whereby filtered oil is metered to all vital parts from a central control point.

The L design of the large machines provides ample chip clearance as well as accessibility. The high speeds of the smaller machines can be employed continuously. We invite you to ask for full specifications, attachment and tooling details, or to let us advise on screw machine applications to your production requirements. B.S.A. automatic screw machines are *fast—accurate—reliable.*

EARLY DELIVERY—½" & ¾"

INTERNATIONAL MACHINE TOOL EXHIBITION 1956
June 29-July 6
Olympia - London

STAND No. 49 GRAND HALL

B.S.A. TOOLS LTD • BIRMINGHAM • ENGLAND

Makers also of a range of single-spindle automatics built to metric standards—primarily for users of the continental type

SOLE AGENTS GT. BRITAIN: BURTON GRIFFITHS & CO. LTD., KITTS GREEN, BIRMINGHAM 33. Tel. STECHFORD 3071 (10 lines)

Light Bar Rolling

by

FIRTH BROWN

ALLOY STEELMAKERS · FORGEMASTERS · HEAVY ENGINEERS

THOS. FIRTH & JOHN BROWN LIMITED · SHEFFIELD

For compact, flexible, unfailing POWER

Where space is a limiting design factor and the requirement is for a unit which is capable of producing power out of all proportion to its small size—in a great many cases the solution is to install a Plessey High Pressure Hydraulic Pump. Current applications of this pump in heavy duty agricultural and engineering equipment are as varied as they are numerous—and if the day-to-day increase in new users is any guide, there is a wealth of possibility for the Plessey Hydraulic Pump in industry as a whole.

These important products . . .

TRACTORS · LIFT TRUCKS · BRAKE SYSTEMS · CEMENT MIXERS
CRANES · GAS TURBINE ENGINES · EARTH MOVING EQUIPMENT
INJECTION MOULDING MACHINES
MACHINE TOOLS · METAL DRAWING MACHINES

fit **Plessey**

BALANCED PRESSURE-LOADED BEARING
HYDRAULIC PUMPS

If you have a problem which involves hydraulic power, get in touch with Plessey—they may well be able to provide the answer—simply, efficiently and economically.

The Plessey Company Limited · Ilford · Essex

HP7

SPENCER

FOR STEEL SHEETS

We cover the whole country

OUR FOUR BRANCHES ARE AT YOUR SERVICE:

H. F. SPENCER & CO. LTD.

Mitre Works, Eagle Street, Wolverhampton
Telephone: Wolverhampton 22266/7/8/9
Telegrams: 'Spencerian'

Stadium Works, Dogford Road, Royton, Nr. Oldham, Lancs.
Telephone: Oldham Main 4204 and 7851

27, Temple Back, Bristol
Telephone: Bristol 28109

Talbot Road, West Ealing, London, W.13 Telephone: Ealing 9671

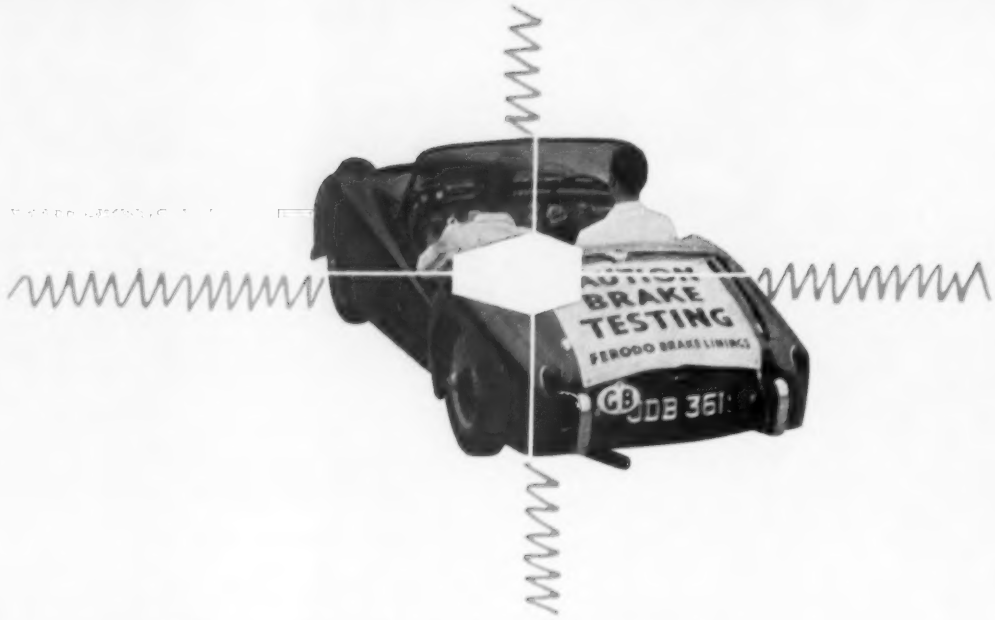
QUICK DELIVERY

Steel sheets : Cold-reduced
Hot-rolled
Galvanized or black

Also mild steel plates up to and including ¼in.
SHEARED TO YOUR SIZES

MAY WE SEND YOU OUR STOCK LIST?

If you would like to have it regularly, kindly drop a card to our nearest branch.



The car with a Built-in brain

This car of the Ferodo Test Fleet is packed with equipment to record and analyze brake performance. For, when arranging schedules for tests, Ferodo research workers must know what a brake lining is expected to do under practical conditions, and that is what these instruments tell them.

There is a high-speed multi-pen recorder which notes four parameters of brake performance: speed, deceleration, brake drum temperature and rate at which work is done at the brakes.

This information is collected electronically, and used by Ferodo to devise accurate, reliable testing schedules that help to produce brake linings highly resistant to fade and wear.

The electronic calculating unit installed in the boot of the TR.2.

The power pack for the electronic apparatus, on the right of which may be seen some of the intricate cable connections.

FERODO

ANTI-FADE Brake Linings

FERODO LIMITED · CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*

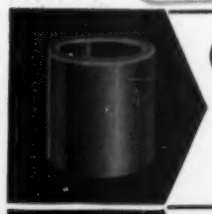
NO MACHINING

NO REAMING

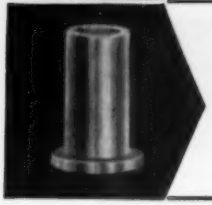
NO OIL HOLES

THE KEY TO INCREASED PRODUCTION

Where bearings and bushes are being used production output can be increased and production costs reduced by specifying Compo and Powdiron. These self-lubricating, anti-friction bearings are produced by the powder metallurgy process, formed in hardened steel dies. They are finished to very close tolerances and supplied ready for press fitting without reaming or machining. Furthermore, their oil impregnation dispenses with oil grooves, oil holes or lubricators. Specify Compo and Powdiron and speed up *your* plant production.



COMPO
POROUS BRONZE BEARINGS



Powdiron
SINTERED IRON BEARINGS

A comprehensive range of standard cylindrical bushes is available from stock
May we send you our literature LCP/1 ?

BOUND BROOK BEARINGS LTD.
TRENT VALLEY TRADING ESTATE, LICHFIELD, STAFFS
Telephone: Lichfield 2027-2028 (A Birfield Company) Telegrams: Boundless Lichfield

UNPACKAGING PROBLEM?

TIME
FIVE
MINUTES

SOLUTION....

Paynes

Rippatape

TRADE MARK

A MAGNIFICENT SALES AID FOR YOUR PRODUCTS

Pull Tear-Tab on Container wall and "zip" it's open... No damage to contents through knives or other tools

A BOON FOR "SELF-SERVICE" DEPARTMENTS CHEAPENS HANDLING AND LABOUR COSTS AND SPEEDS UP RE-STOCKING OF COUNTERS

Ask your usual Container Manufacturer for "RIPPATAPED" Cases. In case of difficulty—contact us for list of Manufacturers Rippatape Equipped. Help <u>your</u> products sell faster and build goodwill with your customers

SEND FOR ILLUSTRATED FOLDER OR
ASK OUR REPRESENTATIVE TO CALL

TIME
30
SECONDS

P. P. PAYNE & SONS LIMITED

HEAD OFFICE & FACTORIES
HAYDN ROAD, NOTTINGHAM
Telephone: NOTTINGHAM 66648

LONDON OFFICE & SHOWROOMS
BUSH HOUSE, LONDON W.C.2
Telephone: TEMPLE BAR 5964

COMPANIES OVERSEAS

P. P. Payne & Sons (Canada), Ltd.,
468 King Street West,
Toronto, 2 B,
Ontario, Canada.

P. P. Payne & Sons (South Africa), Ltd.,
404/5 Safric House,
Corner Eloff and Plein Streets,
Johannesburg, South Africa.

P. P. Payne & Sons (Australia), Ltd.,
545 Pacific Highway,
Crows Nest, N.S.W.,
Australia.

A TURN TO THE RIGHT . . .

At the next corner, or the next-but-one, our lady driver will turn to the right (or will it be the left?) taking steel with her in a multitude of forms. Body work, chassis, engine, the wheel she holds, the foot pedals she sometimes uses and many other components are made from steel—more often than not, Steel by LEE. Our daily output of cold rolled strip, bright drawn bars and "Trubrite" stainless steel feed the production lines of leading automobile, motor cycle, and bicycle manufacturers. Limited only by the fields in which steel is used, LEE'S products feature extensively in well-known domestic appliances, cutlery, and kitchen equipment manufacture, shipbuilding yards and aircraft plants, etc., to name but a few. A word about steel with LEE of SHEFFIELD will be a turn to the right.

LEE *of Sheffield*

TRUBRITE

ARTHUR LEE & SONS LIMITED

HEAD OFFICE AND WORKS: TRUBRITE STEEL WORKS · BEESTON HALL · NEAR SHEFFIELD

Spelaeology, *extending its thin tentacles of human exploration into the potholes and underground rivers of the earth, emphasizes the problems of inaccessibility. In industry and the home, in machinery where maintenance for lubrication is difficult or undesirable, this problem of inaccessibility is overcome by the use of "Reservoil" sintered-metal oil-retaining bearings. Feeding oil to the bearing surface by capillary action, "Reservoil" bearings ensure trouble-free lubrication, automatically.*

Bulldozers are an instance where 'Reservoil' bearings are used to advantage. They are supplied in shapes and sizes for every normal medium duty, but attention is drawn to the range of plain cylindrical bearings to B.S.I. Standard dimensions. Write for Catalogue SD41

Reservoil

SINTERED METAL

OIL RETAINING BEARINGS

CENTENARY

1856-1956

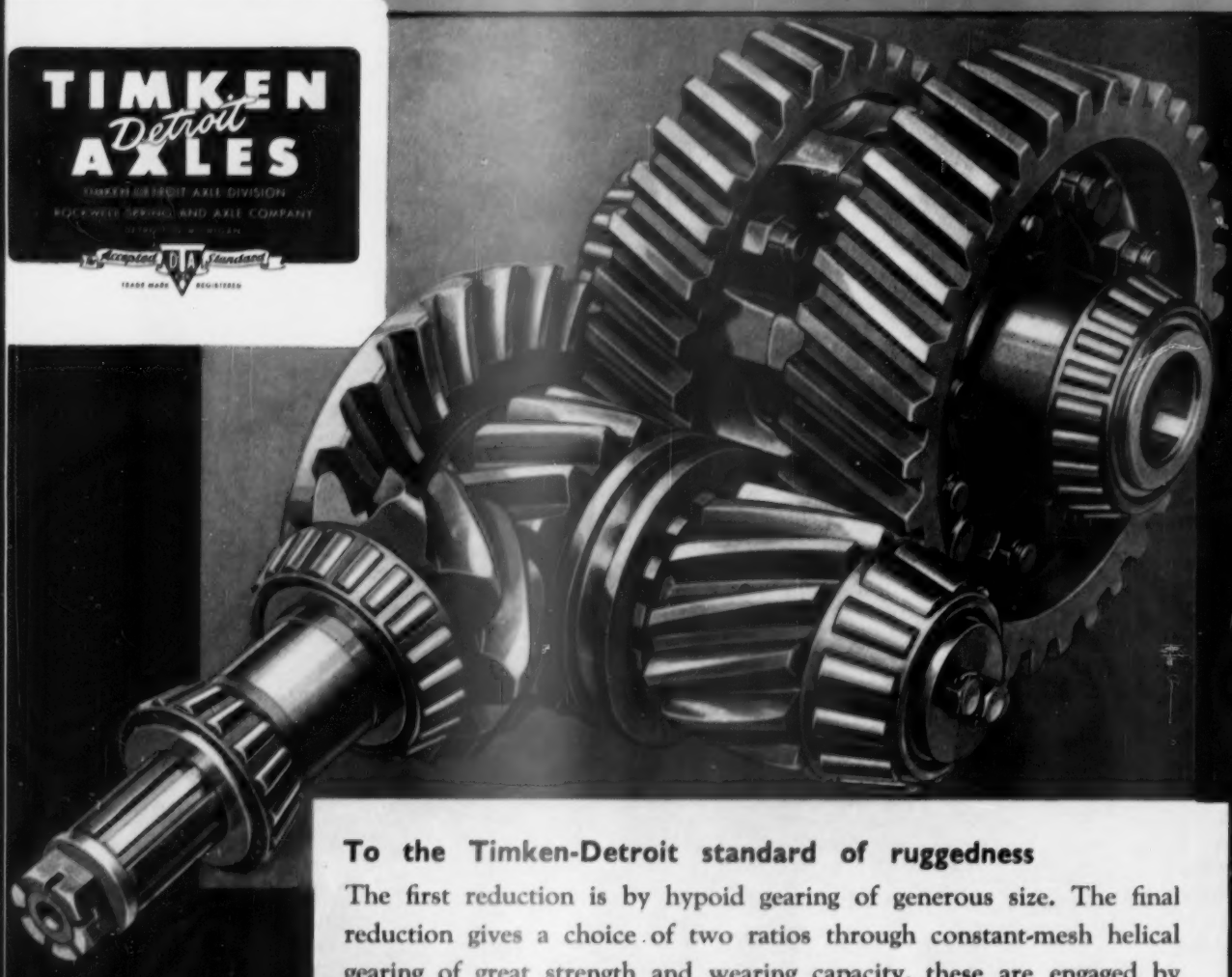
THE MORGAN CRUCIBLE COMPANY LTD., BATTERSEA CHURCH ROAD, LONDON, S.W.11 BATTERSEA 8822

SM 119

HOFFMANN
BALL AND ROLLER
BEARINGS
ON QUALITY
STANDARD EQUIPMENT ON MOST
OF BRITAIN'S MOTOR CARS
THE HOFFMANN MANUFACTURING CO. LTD. CHELMSFORD, ESSEX.

TIMKEN-DETROIT AXLES

With 2-Speed Hypoid and Helical Drive



To the Timken-Detroit standard of ruggedness

The first reduction is by hypoid gearing of generous size. The final reduction gives a choice of two ratios through constant-mesh helical gearing of great strength and wearing capacity, these are engaged by robust dog-clutches.

High-duty Timken tapered-roller bearings: high-duty differential.

Brakes: hydraulic-dual primary or air-actuated.

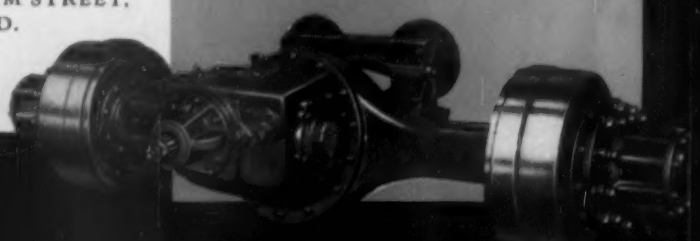
Front axles are also available.

Exclusive European distributors for The Timken-Detroit Axle Division, Rockwell Spring and Axle Company, Detroit, Michigan, U.S.A.:—

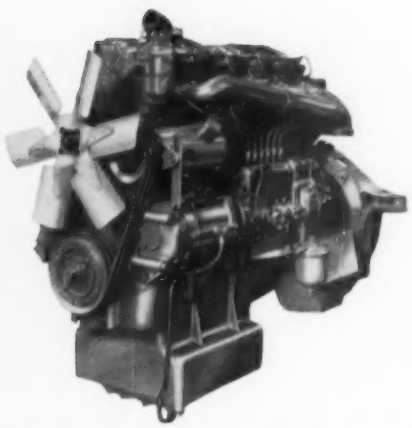
AUTOMOTIVE PRODUCTS
COMPANY LIMITED
BROCK HOUSE, LANGHAM STREET,
LONDON, W.1, ENGLAND.

GUARANTEED AXLE-SHAFTS AND AXLE HOUSING

Timken-Detroit torsion-flow axle-shafts, heat-treated and shot-peened, are guaranteed for 100,000 miles of operation or for three years, whichever occurs first, against defective materials and workmanship. The forged axle housing is guaranteed for the life of the vehicle.



AUTOMOBILE ENGINEER



TRANSFER LINES HAVE BEEN INSTALLED FOR MACHINING THE CASING AND THE CYLINDER HEADS OF THE NEW 470 in³ CAPACITY A.E.C. DIESEL ENGINE. THE CAPACITY CAN BE REDUCED TO 410 in³ BY ALTERNATIVE SMALL-BORE LINERS

CONTENTS

1 Editorial 1956

2 Machining Engine Casings and Cylinder Heads
A.E.C. transfer lines for flow production on alternative-sized components

13 Fan Position J. L. Koffman *Theoretical analysis shows advantages in having the fan in front of the radiator*

16 Cooling Air Flow *The venturi as a cooling system design aid*

19 German Commercial Vehicles *Some of the latest developments and design trends in trucks, trailers and special purpose vehicles*

28 Machine Riveting *Turner spinning and rotary vibrating machines for component assembly*

31 Greyhound Scenicruiser Coach *A new American vehicle for long-distance express operation*

34 The Cold Roll Forming Process *A rapid and accurate method for producing a wide variety of shapes*

37 Current Patents *A review of recent automobile specifications*

Published the second Wednesday in every month by ILIFFE & SONS LIMITED
Dorset House, Stamford Street, London, S.E.1.
Telephone · Waterloo 3333 (60 lines)
Telegrams · Sliderule, Sedist London.
The annual subscription inland and overseas is £2 17s. 0d. including the special number Canada and U.S.A. $8·50

BRANCH OFFICES
Coventry · 8-10 Corporation St.,
Telephone · Coventry 5210
Birmingham 2 · King Edward House, New St.
Telephone · Midland 7191-7
Manchester 3 · 260 Deansgate
Telephone · Blackfriars 4412
Glasgow, C.2 · 26B Renfield St.,
Telephone · Central 1265-6

On-the-spot service

GLASGOW

SKF

BALL & ROLLER BEARINGS

The shipyards of Clydebank have established Glasgow as the greatest engineering centre in a country renowned for engineering achievements, a thriving city with a wide variety of other activities heavy and light. Skefko serves the Scottish engineering industry through Branch offices at Glasgow, Edinburgh and Aberdeen—offering an on-the-spot service of high quality ball and roller bearings and expert technical advice to all users of anti-friction bearings in the country.

GLASGOW: 165 HOPE STREET, C.2.
Tel: Central 3268/9. Grams: Skefko, Glasgow, C.2.

ABERDEEN: 23 WINDMILL BRAE.
Tel: Aberdeen 27824. Grams: Skefko, Aberdeen.

EDINBURGH: 117, GEORGE STREET, 2.
Tel: Edinburgh 34867. Grams: Skefko, Edinburgh, 2.

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS
THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES · BALL · CYLINDRICAL ROLLER · TAPER ROLLER AND SPHERICAL ROLLER

One of a series of advertisements featuring the main towns where SKF service is centred. Other SKF offices are at :—BELFAST · BIRMINGHAM · BRISTOL · CARDIFF · DUBLIN · EXETER · LEEDS · LEICESTER · LIVERPOOL · LONDON · LUTON · MANCHESTER · NEWCASTLE-ON-TYNE · NOTTINGHAM · SHEFFIELD · SOUTHAMPTON G127

Editor J. B. Duncan

Editorial Staff T. K. Garrett, A.M.I.Mech.E. A.F.R.Ae.S.(*Associate Editor*)
F. C. Sheffield

DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

1956

AT the beginning of a new year, and in the first number of a new volume, it is pertinent to discuss desirable lines of automobile design development. As the sole object in making automobiles is to sell them, obviously it is all important to know what is desired by the owner, whether of a passenger car or a fleet of commercial vehicles. It is, of course, almost needless to say that in this country and Europe lower fuel costs and greater reliability are still the characteristics most called for. There is, however, a certain conflict between these characteristics. Improvement in the miles obtained per gallon of fuel is greatly dependent upon the development of engines with increased thermodynamic and volumetric efficiencies, but this means heavier engine loading and, for the same scantlings, shorter life between major overhauls. Improved reliability rather than lower fuel consumption is the more desirable.

In any case, the petrol engine has now reached such a pitch of efficiency that spectacular advances are not to be expected. It is with items other than the power unit that major changes may take place. For example, the wider use of hydraulics will have to be given earnest consideration. All know the tremendous interest aroused by the new Citroën, chiefly because of its centralized hydraulic system for actuating and controlling several mechanisms, including the clutch, the brakes, the steering and the suspension. This system has yet to be proved in normal service. It is, however, interesting that developments along similar lines are being actively pursued in the United States of America.

One American accessory manufacturer is already exploring the potentialities of a central hydraulic system with a variable volume pump for operating such items as the fan, the air conditioning plant, the steering, the brakes, and window and seat movements. We do not suggest that manufacturers in this country should go to such lengths, but the possibility of a further use of hydraulics is well worth investigation.

In the U.S.A. considerable attention is also being paid to air-hydraulic suspension systems designed to give a low oscillation frequency which is adjustable over an appreciable range. Two forms have been developed; a bellows type and a metal cylinder type. In both, the internal pressure increases as the load increases, and therefore the load deflection rate also increases. However, since the oscillating frequency is proportional to static deflection, and because a levelling valve maintains a constant static deflection regardless of load, the frequency remains constant. It is suggested that the desirable frequency may well be less than the 78 cycles per minute now generally accepted as the optimum rate. These systems are said to eliminate harshness caused by friction and the fade due to aeration of the hydraulic fluid.

The chief problems to be solved for successful application of the hydraulic systems in automobile practice are efficient sealing and the prevention of fluid leakage, boiling and, as just mentioned, aeration. Fortunately, there are a number of organizations in this country with a wide knowledge of hydraulic systems, and we have no doubt that if vehicle manufacturers show sufficient interest, the specialist firms could quickly develop efficient hydraulic systems for any feasible applications.

There is, of course, still room for improvement in commercial vehicle suspension systems, and we are looking forward to seeing at the Commercial Show next September the results of development work now in progress. Certain British manufacturers have given a lead to the world in recent years, and every effort must be made to retain the lead. For independent front suspensions, on vehicles with separate chassis frames, the conventional double transverse wishbone link system has much to commend it. When the chassisless form of construction is employed, the Ford type of lay-out may be considered superior, because of the wide spacing of the anchoring points and its relative freedom from tyre scrub.

Ventilation both of cars and public service vehicles still leaves much to be desired in many designs. Unfortunately, little data are available as to the pattern of air pressure distribution over the vehicle, and how it varies with the speed, but such knowledge is a fundamental requirement for efficient design. It is, for example, pointless to put an extractor vent in a region of high pressure or an intake vent in a low pressure region. In private cars, the triangular ventilating panels at the front of the door lights tend, in many instances, to obstruct the driver's range of vision. Other arrangements have proved more effective; for example, a vent in the trailing edge of the canopy or in each rear quarter panel. Any design feature which improves visibility without affecting other amenities is well worth while, since it greatly reduces driving strain and contributes to road safety.

MACHINING ENGINE CASINGS

A.E.C. Transfer Lines for Flow Production on Alternative-Sized Components

At the commencement of the engine casing line a Cincinnati duplex machine mills the joint and sump faces in two passes

IN the relatively short period of a few decades, Southall, where the A.E.C. plant is sited, has undergone a metamorphosis from a semi-rural district to become an "over-industrialized area." As a consequence, any plans to extend productive capacity in the area were beset with difficulties. Under the conditions obtaining it was not possible to build additional machine shops or to employ an increased number of operatives. Necessarily, therefore, the reorganization of the engine-building shops at the A.E.C. plant had to be achieved by improved equipment, better utilization of equipment, careful control and the elimination of unproductive time in order to ensure the most economical use of existing floor space and the most effective use of available manpower.

Until recently component parts of the engines were machined on a batch production basis and the equipment consisted mainly of general-purpose machine tools supplemented by a few specially designed tools for specific operations. The introduction of a new range of engines presented the opportunity to reorganize the engine-building shops and to re-equip the section engaged on machining the main components, the engine casing and the cylinder heads, for continuous production on a line basis. Economy in production rather than a speeding-up of the rate of production was the overriding consideration. To this end, the closest collaboration was, from the inception, maintained between design and production departments.

The amount of automation to be built into the lines was determined primarily by the production rate required and the extent to which capital investment could be justified economically. On the production rate depends the cycle time which sets a limit to the maximum duration of any single operation if the duplication of machines to balance output is to be avoided. A rate of three sets of engine components per hour was decided upon, that is, one engine casing and two cylinder heads each twenty minutes. A careful time study was undertaken to break down the many machining operations involved and to facilitate their regrouping into convenient units of work to be completed within the limits of the cycle time.

One of the main objects was to reduce the physical effort required of the operators and for this purpose machines for the engine casing line are linked by roller tracks along which the components are pushed or pulled. No heavy lifting is necessary; air hoists are provided where the component has to be lifted on to or off the line, and at changes of working level power-actuated lifting sections are provided in the roller track. Machine cycles are automatically controlled and when finished the machine is stopped and awaits unloading. In general, the operators' duties consist of unloading and reloading a machine, starting the machine cycle and passing on to repeat the procedure on succeeding machines within the limits of the cycle time. An indication of the extent to which mechanical aids have been applied may be gained from the cylinder head transfer line. On this, an average figure of 30 h.p. per operator is available, which contrasts with the average figure of 7·5 h.p. per operator under the earlier method of batch production.

Since the cycle time is relatively generous the operator

Three vertical cylinder boring machines rough and finish the bores. The centre machine cuts the annular grooves for the liner sealing rings

AND CYLINDER HEADS

can attend several machines, and all machines are operated at speeds and feeds well below their maximum capacity. In practice, machining times are arranged for optimum conditions to ensure consistent accuracy and maximum tool life and thus to minimize interruptions for servicing and maintenance. Should it become necessary to increase the rate of production, the cycle time could be reduced and the line manned by an increased number of operators. On the present cycle time of 20 minutes individual machines have a certain amount of idle time which could readily be reduced if desired. Typical of the individual machine cycle times on the casing line are (1) milling the sump and joint faces, 14 min, (2) roughing and semi-finishing six cylinder bores, 13 min, and (3) deep-drilling the oil gallery and the camshaft bores, 17·3 min. In these three instances the individual cycle efficiencies—actual machining time *v.* cycle time, including loading, locating, tool approach, tool feed, tool return and unloading—are 64·3 per cent, 67·7 per cent and 58·4 per cent respectively. The lower efficiency of the deep-hole drilling machine arises from the need, at regular intervals, to back feed the tool in order to clear the hole and to re-approach.

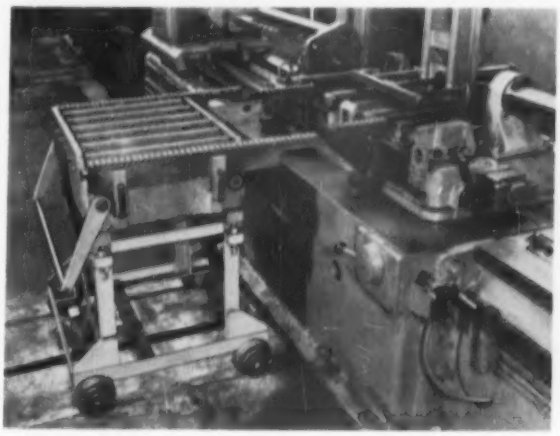
Operating under such relatively favourable conditions, tool life is increased by approximately 60 per cent as compared to the life previously obtained with manual operation under conditions of batch production. Overall production times have been lowered from 1,060 to 360 man-minutes on the casing and from 450 to 60 man-minutes on the cylinder head, 18 operatives being employed on the casing line and six on the head line for the designated output.

To minimize capital expenditure on the new lines, existing machine tools previously used on batch production were utilized where practicable and were modified mechanically and electrically to work on an automatic cycle. Actually 12 of the 36 general-purpose and special machines in the casing line and four of the seven general-purpose machines in the head line are in that category. The overall investment of capital in the lines compares most favourably with that which would be needed to achieve the same rate of production by the earlier batch production method. Batch production would necessitate more machines, more floor space, more operatives, and the introduction of double-shift working.

In order to ensure the most effective utilization of the production facilities embodied in the lines, the machine units and their associated fixtures have been designed to accept two or more sizes of engine component to the same basic design. By this means flexibility of production is economically possible to meet the fluctuations of demand. Wherever practicable, provision has been made for a larger component by the use of common fixture bases having alternative location pins. The different machining patterns involved are covered by the use of alternative multi-spindle attachments for such operations as drilling, boring, reaming and tapping. These attachments are designed for easy removal as complete units and are stored alongside the lines while the alternative units are being used.

Currently, the lines are tooled for components of the new engine having a swept capacity of 470 in³ or, with the interchangeable small-bore liners fitted, of 410 in³. Fixtures, however, are of adequate size to receive larger components for an engine of 700 in³ capacity, or of 600 in³ with small-bore liners. Ultimately, it is the intention to operate the lines for three or four weeks on components of one size, during which period a "float" will be accumulated. The tooling will then be changed to machine parts of another size which will be produced for several weeks before a change is again made.

With few exceptions, the A.E.C. designed and manufactured the tools, fixtures, multi-spindle attachments, automatic transfer equipment and swarf conveyors for the cylinder head line. Fisher and Ludlow Ltd. were responsible for the



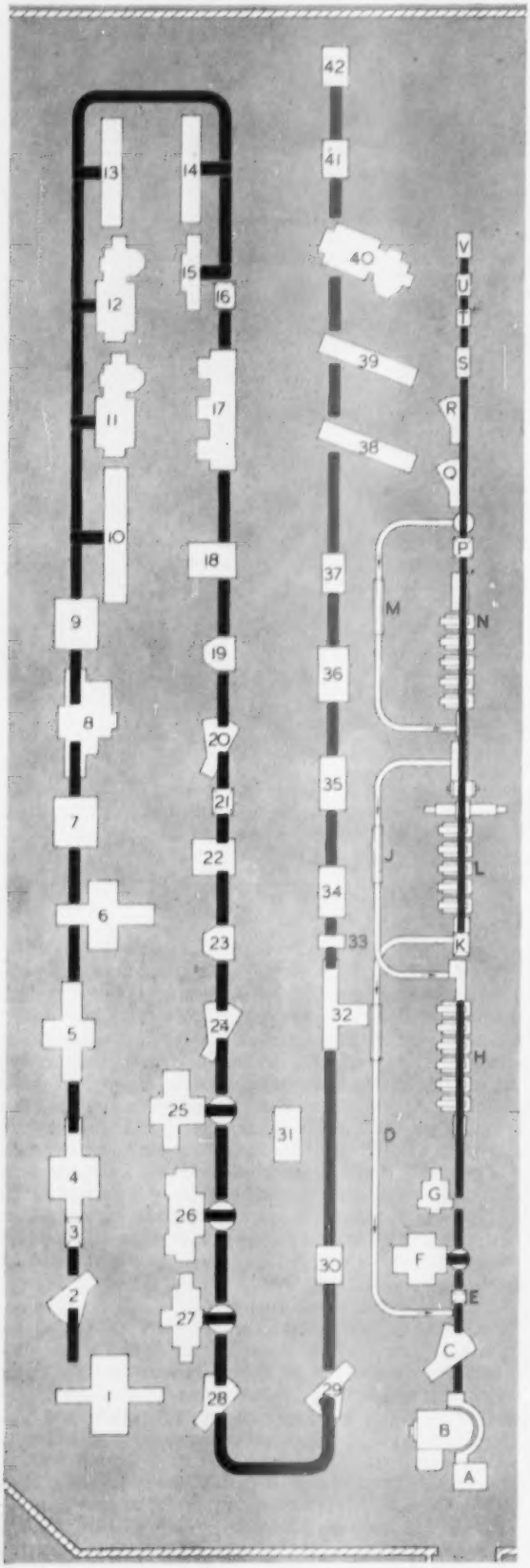
Trolley with elevating transverse rollers for side loading the component from roller track to machine

platen return system on the head line and the roller track on the casing line. James Archdale and Co. Ltd., collaborated in the design and layout of fixtures and equipment in connection with machines of their manufacture in both lines.

Engine Casing Line

To provide automatic transfer facilities for a component of the size and complication of a six-cylinder engine casing would not be economic when related to a production rate of three units an hour. With a system of manual transfer, however, the investment was justified and the savings to be effected were substantial. Accordingly, the line was laid out with the machines interspaced by roller conveyor tracks and the casing is pushed from station to station. Location at successive machining stations is provided by two retractable dowels engaged in holes machined in the sump face. The standard height of the conveyor track is 32 in and all new plant was designed to suit that level. However, in order to use several Cincinnati duplex millers at the commencement of the line, a higher operating and transfer level is necessary. Change of level is effected by an air-operated rise-and-fall section in the roller track.

The castings are shot-blasted, pickled and painted before being brought to the line where they are stacked on the floor alongside the Cincinnati duplex miller at the first machining station. An air hoist is used to lift the casing and load it into a fixture on the machine table where, lying on its side, it is located on jig pads and is air clamped. The fixture bridge, carrying the clamping members, is hinged and is raised and lowered by means of an air cylinder. Sump and joint faces are machined, in two passes, using Galtona carbide-tipped serrated blade cutters and a feed of 9 in/min. In an automatic cycle the first pass roughs both faces, removing about $\frac{3}{16}$ in, the spindles retract to clear the



cutters during the return traverse, cut is applied to the spindles for the second pass, removing 0·010 in to finish the sump-face and semi-finish the joint face, the spindles again retract for the return to the starting position, and the machine is stopped. An allowance of 0·020 in is left on the joint face for a finishing cut at a later stage.

An air hoist is used to unload the casing and deposit it, sump face uppermost, on the roller track for transfer to an Archdale radial drill. The drilling fixture has a floating bush plate which is located on casting pads and is hand clamped. Two holes that serve as master locations for all subsequent operations are drilled and reamed and, to complete a time cycle of about 12 min, ancillary operations, such as cutting clearances for timing gears and drilling holes that are too closely pitched for multi-spindle operations, are performed. Here, again, the bush plate is raised by an air cylinder to allow the component to be unloaded and passed to a roll-over fixture in the track and then transferred, sump face downwards, to an Archdale 4-spindle horizontal duplex miller. This machine has a platen type table carrying a fixture that has two retractable locating dowels to engage the dowel holes in the sump face. The machine control is electrically interlocked with these dowels to ensure that the cycle cannot be started unless they are correctly located.

Four Galtona cutters are used; the upper pair finish the side cover faces, while the lower pair semi-finish the timing case sides and the injection pump and the dynamo mounting faces, leaving 0·010 in. The nearside lower cutter has special long blades and is used to machine, at right angles, simultaneously with the dynamo face, two pads on the sump flange. During this stage of the operation the feed is automatically reduced from 9 in/min to half that rate and then restored to full rate for the remainder of the cycle. The component is unloaded at the end of the table travel and the empty table returned to its loading position. Manual transfer brings it to a track lift section where it is raised by an air cylinder to a new level and then passed to a Cincinnati duplex miller, the table of which is aligned with the track.

Clamped on a fixture similar to the previous one, timing

Layout of flow lines

Engine Casing Line

1 Cincinnati duplex miller.
2 Archdale radial drill.
3 Roll-over cradle.
4 Archdale 4-spindle miller.
5 Cincinnati duplex miller.
6 Cincinnati duplex miller.
7 Asquith 6-spindle vertical borer.
8 Holroyd 6-spindle vertical borer.
9 Asquith 6-spindle vertical borer.
10 A.E.C. double-ended deep-hole borer.
11 A.E.C. horizontal borer.
12 A.E.C. horizontal borer.
13 Archdale horizontal duplex multi-spindle drill.
14 Archdale horizontal duplex multi-spindle tapper.
15 Archdale horizontal duplex cam unit borer.
16 Roll-over cradle.
17 Archdale 3-gang tappet hole machine
18 Archdale multi-spindle drill.
19 Archdale hydraulic multi-spindle drill.
20 Archdale radial drill.
21 Motorized roll-over cradle.
22 Archdale hydraulic multi-spindle drill.
23 Archdale hydraulic multi-spindle drill.
24 Archdale radial drill.
25 Archdale horizontal 3-spindle sensitive drill.
26 Archdale horizontal duplex multi-spindle drill.
27 Archdale horizontal duplex multi-spindle tapper.
28 Archdale radial drill.
29 Archdale radial drill.
30 A.E.C. washing machine.
31 Inspection table.
32 Archdale vertical platen-type miller.
33 Asquith vertical single-spindle drill.
34 Liner fitting station.
35 Water test stand.
36 Fettling stand.
37 Bearing-cap fitting station.
38 A.E.C. line borer.
39 A.E.C. line borer.
40 Richards horizontal 3-spindle borer.
41 A.E.C. washing machine.
42 A.E.C. oil spray booth.

Cylinder Head Line

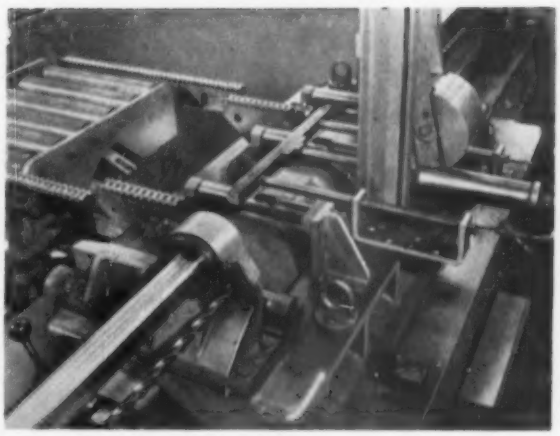
A Loading table.
B Asquith 2-spindle, rotary table, vertical miller.
C Archdale radial drill.
D No. 1 platen return conveyor.
E Roll-over cradle.
F Cincinnati duplex miller.
G Parkinson horizontal miller.
H No. 1 battery; 6 Archdale vertical hydraulic drills.
J No. 2 platen return conveyor.
K Roll-over cradle.
L No. 2 battery; 5 Archdale vertical hydraulic drills, Archdale duplex horizontal drill, Pollard 3-way multi-spindle tapper.
M No. 3 Platen return conveyor.
N No. 3 battery; 4 Archdale vertical hydraulic drills, A.E.C. 6-spindle tapper.
P Roll-over cradle.
Q Archdale radial drill.
R Archdale radial drill.
S Dawson washing machine.
T Hare 7½ ton hydraulic press.
U Water test tank.
V Inspection table.

case sides and mounting faces are finish machined to a tolerance of 0·002 in, since these faces affect the centres of timing and auxiliary drive gears. On completion the casing is transferred and side-loaded and air-clamped on a special wide-spaced Cincinnati duplex miller equipped for automatic retraction on the spindles on the return travel. End faces of the casing are finish milled in a single pass and the casing is returned to the line where an air-operated section of the track lowers it to the standard level of 32 in. Each of these duplex millers is equipped with a dust-extraction system.

All six sides of the component having been milled, it is passed to an Asquith vertical cylinder borer having a detachable 6-spindle, fixed centre head. To facilitate loading the fixture is provided with a pull-bar, manually actuated by a rack and pinion gear. A swing type dead stop approximately positions the component which is then positively located by a pair of retractable and interlocked dowels, as before. Clamping is by hand.

To ensure accurate boring conditions, the bars are piloted in running bushes mounted in the base of the fixture and driven by the bars. A helical lead is cut on the end of each bar to assist engagement of the driving keyway with the key in the pilot bush. On an automatic cycle the head makes a fast approach, trips into boring feed and roughs the upper diameter. It then fast feeds until it is in position to bore the lower diameter and simultaneously a second set of boring bits approach to size the upper diameter. When boring is completed, continued feed brings in counterboring bits to rough machine the recess to receive the flange of the cylinder liner.

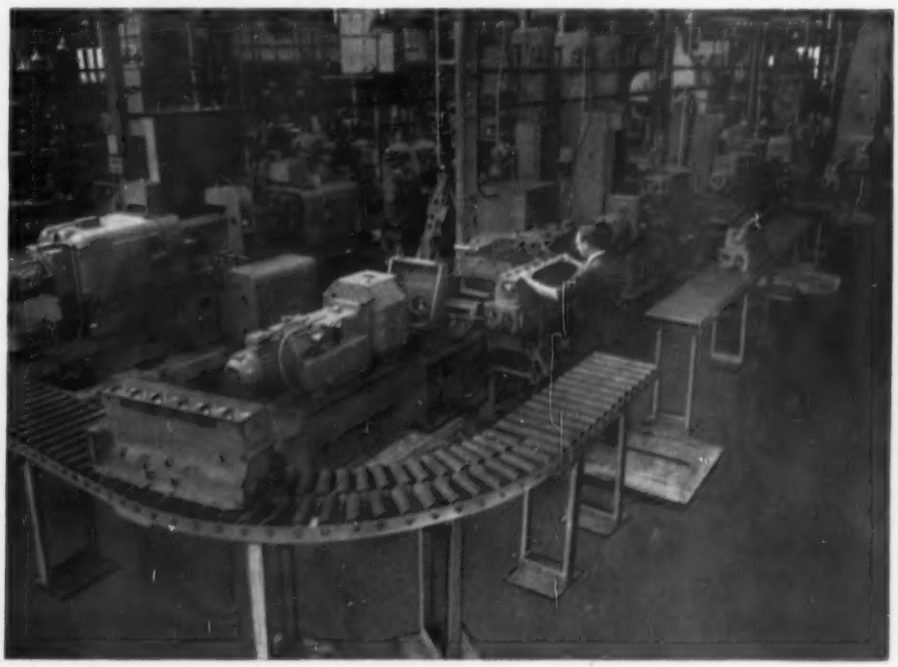
The liner is of the wet type and is sealed at the base of the water jacket by a pair of rubber rings. The recesses for these rings are machined on a Holroyd vertical borer in a similar fixture with running pilot bushes for the cutter bars. An existing, belt-driven machine, this has been specially adapted and equipped for the duty. The tools in the bars are of the extruding and retracting type and a very fine out-feed, 0·001 in per revolution, is provided, terminating in a period of dwell to ensure a smooth finish. Sizing is accurately determined by feeding to a dead stop, the maximum pressure being controlled by means of an adjustable torque limiter in the feed drive.



A.E.C. special deep hole drilling machine for oil gallery and camshaft tunnel bores. View shows fixture and air-operated ejector mechanism

Cylinder bores and counterbores are finish machined on a second Asquith borer equipped with a similar fixture and running pilot bushes. The fixture on each of these three boring machines incorporates in its base spring-loaded rollers. These enable the component to be rolled into position and the clamping action brings the component down to seat on the hardened faces provided, depressing the rollers. Immediately the clamps are released the rollers lift the component clear of the fixture for easy unloading on to the roller track.

From the roller track the casing is then side-loaded on to a special A.E.C. horizontal double-ended deep-hole drilling machine for the drilling of the full-length oil gallery and the boring of the camshaft tunnel. To convey the component from the track to the machine fixture a trolley running on transverse rails in the floor is provided. This trolley carries



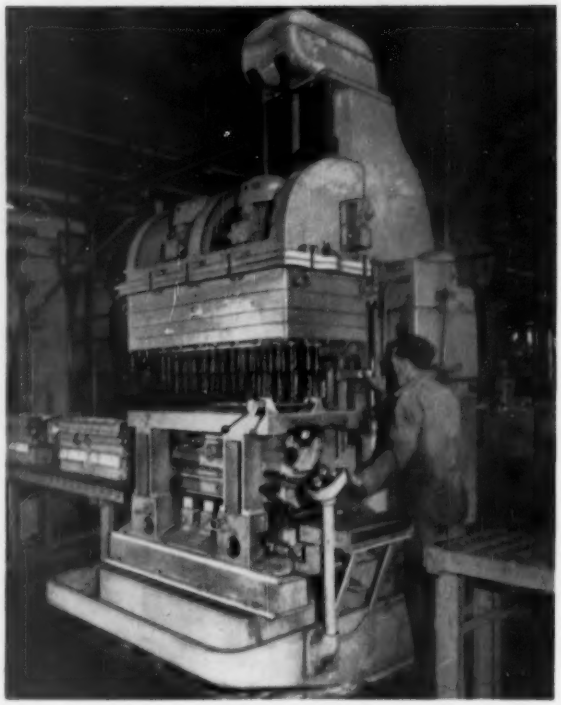
General view of the casing transfer line. In the foreground are Archdale duplex horizontal machines for drilling and tapping the end faces

one set of rollers to accommodate movement of the component in the direction of the track and flanking rollers at right angles that can be raised by a lever-actuated cam to lift the component prior to transfer to or from the machine fixture. The actual loading or unloading is effected by an air-operated "push-pull" device on the fixture. The oil gallery is drilled from both ends simultaneously, penetrating 5 in deep at each stroke at a feed rate of 1·75 in/min and automatically retracting to relieve the drills. A maximum thrust limiting device stops the machine in the event of drills becoming blunted or broken. One head remains stationary for the final breakthrough. Other spindles in the multi-heads rough machine the camshaft tunnel and the bore for an idler gear in the wheelcase.

Similar side-loading trolleys are used to transfer the casing successively to two A.E.C. single-ended boring machines. The first has a 4-spindle head and faces a water cover hole, bores and faces the pump housing, bores and counterbores the camshaft drive gear housing, and rough machines an idler gear bore. On the second machine these roughing operations, with the exception of the water cover hole, are finish machined.

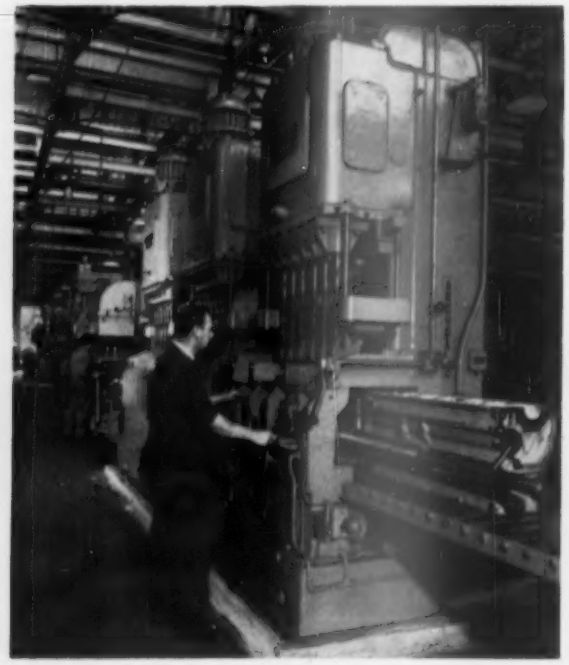
Further drilling, tapping and boring operations on the casing end faces are performed on three Archdale duplex horizontal machines. All are side-loaded as before. A total of 20 holes in the front end and 11 holes in the rear face are drilled. An extended drill plate, retracting to permit loading and unloading, is provided for deep seated holes and combination drills are used for drilling and counterboring. At this stage the roller track loops to bring the component to a parallel line and on the next machine, a multi-spindle tapper, the pattern of holes just drilled is tapped. Each time the machine is cycled a metered supply of oil is fed to each tap.

The idler gear bore, roughed on the A.E.C. borer, and the two ring dowel holes in the rear face, drilled on the Archdale horizontal machine, are next finished by a boring spindle and two reaming spindles on an Archdale duplex horizontal cam unit borer. This completes operations on the end faces and the casing is then inverted in a roll-over cradle—rotating a few times to tip out the swarf—and passed along the track to a special Archdale 3-station machine for drilling, core-drilling and reaming the tappet guide holes.



The sump face is drilled in two passes on this 63-spindle Archdale vertical machine

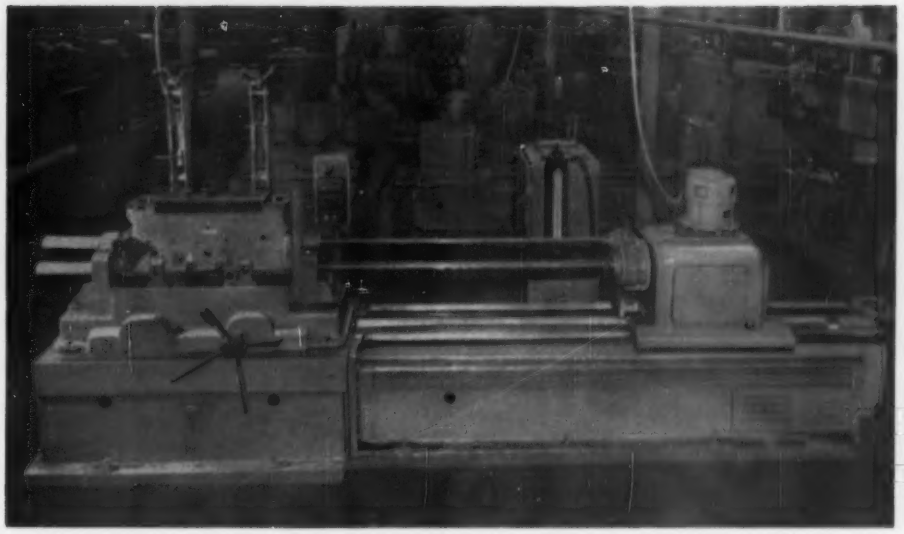
Tappet guide holes are drilled, core drilled, and reamed on this 3-gang vertical machine equipped with a manually operated transfer bar



Each of these machine units has a 6-spindle head of the limited adjustment type. The machine cycles twice, machining six holes each time in components occupying successive stations. The casing is drawn into a bridge type fixture by a manually operated rack and pinion gear, roughly positioned by the draw bar and then air-clamped to the top plate and positively located by dowels. Tools are lowered into the casing at a mid-position, since the proximity of casing webs precludes direct entry of the pilot bushings above the tappet holes. From this position the component is indexed half a pitch in one direction for the first cycle, after the tools are raised clear it is indexed a whole pitch in the other direction for the second cycle, tools are again raised and the component returned to the mid-position for withdrawal. During these operations a pair of trays, push-fitting in the apertures of the tappet enclosure space, trap the bulk of the swarf and thus obviate the possibility of choking the machine ways.

After removal of the swarf trays the casing is passed to an Archdale size No. 4 drilling machine, the multi-head of which has a total of 63 spindles. These are arranged to drill the sump face holes and the bearing cap stud holes at one setting and to counterbore the stud holes at a second indexed setting. Clamping and locating is effected as on the previous machine.

The next operation is to drill and ream the bearing cap dowel holes and to drill the bearing oil holes on an Archdale size D multi-spindle drilling machine. Four settings are required. One half of the casing is drilled, then reamed, and the procedure is repeated for the other half. Final operations on the sump face are performed on an Archdale radial drill. These comprise tapping the cap stud holes and

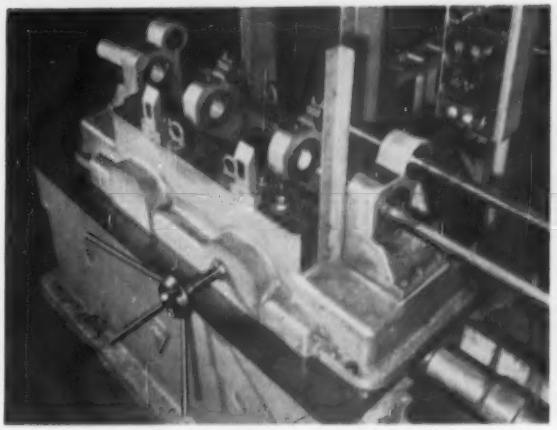


Special A.E.C.-designed horizontal machines bore crankshaft and camshaft bearing housings and face the crankshaft thrust faces

the sump face holes with standard attachments. This is a temporary expedient and eventually the radial drill will be replaced by a multi-spindle tapping machine.

After the tapping operations the casing is fed into a motor-driven roll-over cradle where it is rotated for de-swarfing purposes and is then pushed on the roller track, with the joint face uppermost, to an Archdale size No. 3 hydraulic multi-spindle drilling machine. The detachable head carries 50 spindles for drilling the stud holes, dowel holes, push rod clearances and coolant holes in the joint face. In order to facilitate the machining of certain holes at very close centres, approximately half the pattern of holes is drilled at one pass and then the component is indexed across the machine for the remainder of the holes. The indexing movement is approximately 10 in in order to bring the face completely clear of the area covered by the first drilling pattern.

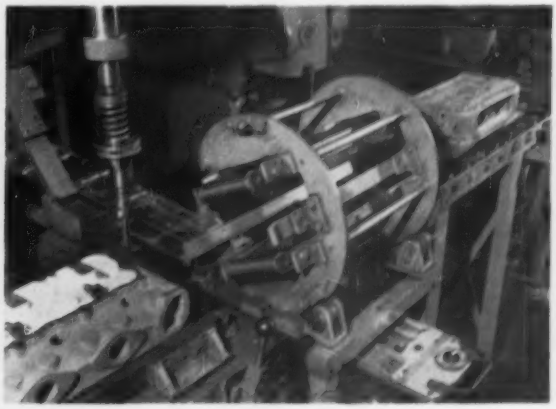
The counterboring of the stud holes and the reaming of the two dowel holes is performed on another Archdale size D driller and then the component is passed to an Archdale radial drill on which all the stud holes are tapped with a standard attachment. A floating bush is provided on the tap to centre it in the stud hole counterbore. Again this general purpose machine will later be replaced by a multi-tapping machine. By means of a turntable in the roller track, the casing is then end loaded into an Archdale three-spindle horizontal drilling machine, with sensitive feed on



(Above) Component fixture for line boring machine, showing keyhole type running bushes for the boring bars

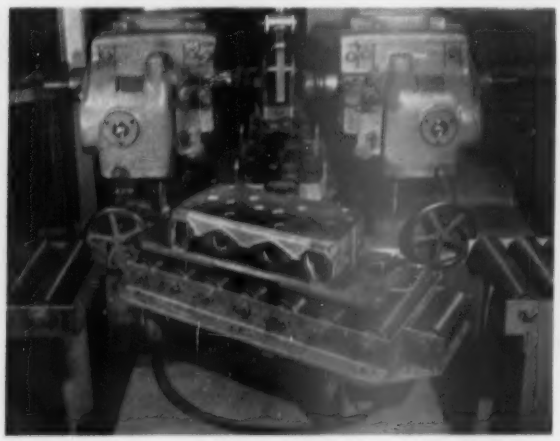
(Left) A twin-spindle, rotary table Asquith miller machines joint and cover faces of the cylinder head. Two components are finished at each revolution of the table

(Below) After attaching the No. 1 platen the component is inverted in a roll-over cradle



two heads, set to one side of the line. Seven transverse holes are drilled through the oil gallery to connect with the vertical drillings from the main bearing seatings and, from the opposite side, one hole to the centre main bearing. At the rear end, the $\frac{3}{4}$ in diameter cross hole is drilled through the width of the block to carry the throttle control shaft. This hole is automatically relieved in the centre portion of its length.

On return to the line, the component is passed in succession to Archdale duplex horizontal multi-spindle machines for drilling and tapping of the holes in the side faces. Certain holes that are too closely spaced for multi-spindle working are then drilled and tapped on an Archdale radial drilling machine. To facilitate handling, a rotary drilling fixture is provided, into which the component can be rolled and then rotated to bring either of the side faces to the correct machining attitude. Loose drill plates are provided to ensure accurate location. After this machine the roller track again loops to make the third parallel line. On this line, the first machine is another Archdale radial drill for doubling the operations on the previous unit or for use in such contingencies as tool breakage or maintenance on other machines.



A uni-directional turntable is used for end loading the duplex horizontal machine for milling the side faces

The head, mounted on No. 1 platen, in position on the slide rails prior to indexing into No. 1 battery

The casing is then ready for its first general inspection and is washed in a special A.E.C. designed booth. This has a power-driven rotating fixture and the casing is thoroughly washed with a multiplicity of high pressure jets with a hot alkaline solution. It is then subjected to an air blast to remove swarf from blind holes. On leaving the booth the casing cools in the air in a parking section of the roller track and any casing selected for inspection is lifted from the track to an off-the-line table to avoid interruption of the flow. After cooling, the component is passed along the track to an Archdale platen-type vertical milling machine. Here the cylinder head joint face is finish machined, using a special 12 in diameter Galtona cutter, at a feed rate of 9 in/min to remove the 0·020 in of stock left on the face at the first machining position in the line. Following this operation, the counterbores to receive the liner flanges are finally sized to correct depth on an Asquith vertical drilling machine. A stepped spigot locating on the upper and lower liner bores centralizes the tool and a floating stop on the tool locates on the finished joint face. Three cutters finish machine the recess to correct depth. This operation is precisely controlled so that the faces of three liners to be covered by one cylinder head are true to a single plane within a tolerance of 0·001 in.

The casing is then transferred on the roller track to a series of fitting stations. At the first the cylinder liners—of the hand-inserted, push-fit type—and their rubber sealing rings are fitted. De-watering oil is applied to the liner flange and the rubber rings. Next the unit complete with liners, is mounted in a roll-over fixture for a water test at 50 lb/in² pressure of the water jacket and the liner seals. It is then passed to a fettling stand where any sharp edges, corners or machining burrs are removed and then to a station where the bearing caps are fitted and stamped for identification.

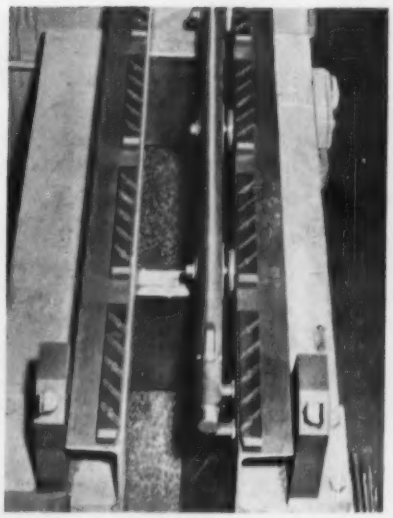
A service lifting eye is fitted and by means of this the component is hoisted and transferred on an overhead runway to the A.E.C. 2-spindle line boring machine where it is loaded into a fixture equipped with keyhole type boring bar running bushes. The machine is arranged to stop always with the boring tools vertical and in line with the keyhole slots in the bushes. This machine is used to rough and semi-finish the main bearings and to semi-finish the camshaft tunnel bearings. On a similar machine, to which the casing is transferred by overhead hoist, these bores are finish machined, removing about 0·005 in stock and maintaining on diameters a close dimensional limit of $\pm$0·0005 in, which is checked by means of a Solex air gauge.

For the final machining operations a specially built Richards type MT boring machine with a 3-spindle facing and boring head is used. Here the end camshaft bore and the idler gear bore are faced, the front main bearing is faced and the centre main bearing is faced and recessed. The special boring bars carry multiple tools that are radially extruded and retracted on an automatic cycle.

At the end of the line the casing receives a second wash in a booth similar to the one described earlier. Finally, it is given a coating of de-watering oil—lanoline and white spirit—as a rust preventive in a spray booth of A.E.C. design and is then delivered either to the engine assembly lines or to storage.

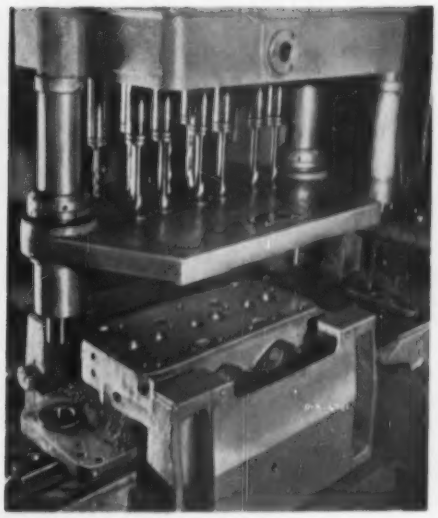
Cylinder Head Line

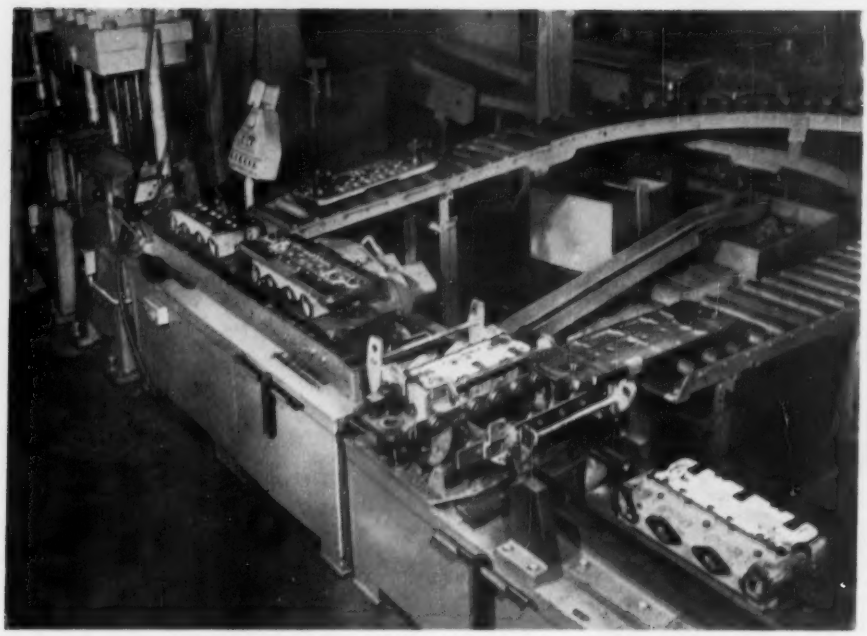
By reason of its size and shape the cylinder head is a more suitable component for automatic transfer machining than is the engine casing. Furthermore, twice as many are required. The question of whether the component should be moved and located on one of its machined faces or on an attached platen, arose immediately power transfer was decided upon. Consideration of the advantages offered by a platen system of more generously dimensioned location bushes, the protection afforded to the machined faces of the component, the practicability of more than one size of com-



(Right) Arrangement of slide rails and automatic transfer bar. Below the machine table is the shaker-type swarf conveyor

(Extreme right) To permit the use of extended pilots, a lifting bush plate is provided at the 4th station of No. 1 battery





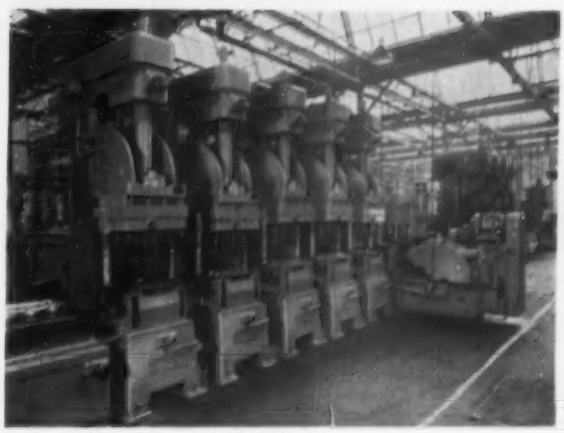
This view between No. 1 and No. 2 batteries shows the roll-over and turntable for servicing No. 1 platen to its return conveyor, and also the inclined swarf conveyor

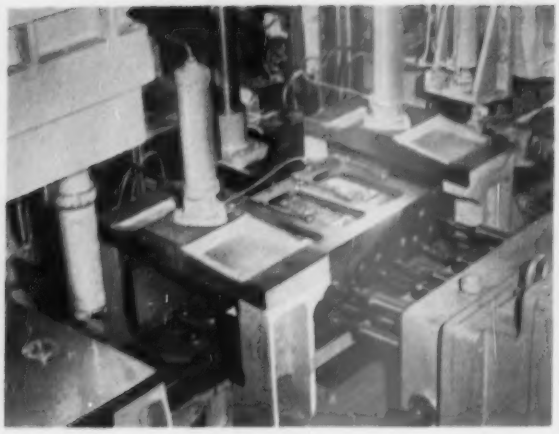
(Below) General view of No. 2 battery, comprising five vertical drilling machines, a duplex horizontal drilling machine and a 3-way horizontal tapper

ponent being accommodated on the same platen and the facility with which platens could be replaced to meet a change in either the size or design of a component, influenced the decision to adopt it. The necessary commitment of such a system—a means of returning platens to the loading point—is met by gravity-type roller runways with an elevating belt conveyor to restore the level. Since three different platens are used in the machining of the cylinder head, three of these platen return systems are built on to the line.

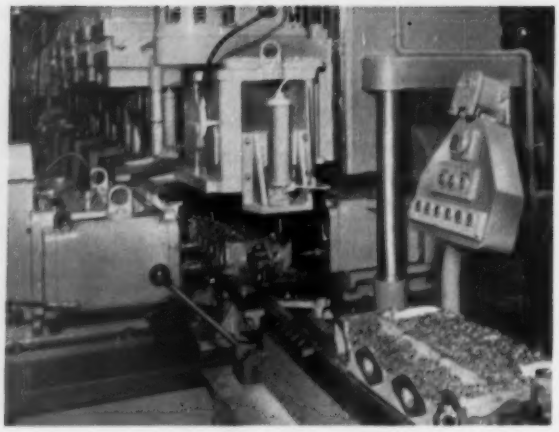
The cylinder heads are pickled, phosphated, and painted before being stacked by a Forklift truck on a loading platform alongside the first machine in the line. This is an Asquith duplex vertical miller with a 6 ft diameter rotary table. On the table are four hand-clamped fixtures, two holding the components for the first operation of milling the valve cover face and two, spaced alternately, for milling the joint face.

Two 14 in diameter Galtona carbide tipped, serrated blade cutters are set respectively at roughing height, to



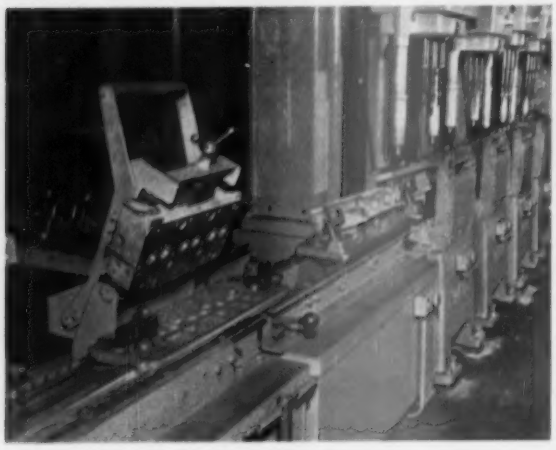


(Above) On the duplex drilling machine in battery No. 2, air jets in the top plate of the fixture blow out the swarf from vertical blind holes preparatory to tapping at the succeeding station

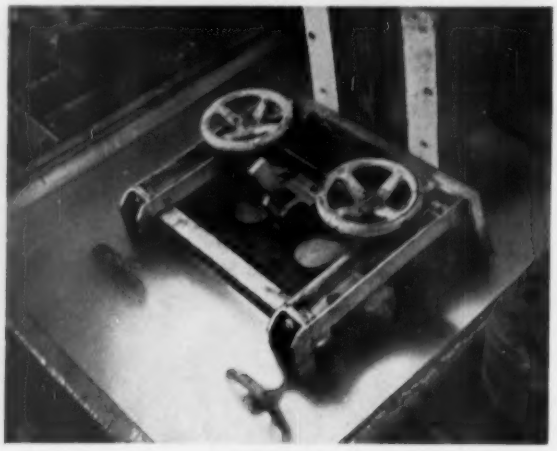


(Above) The 3-way tapping machine terminating No. 2 battery. View shows the control panel and the master control lever

(Below) Counterbalanced lifting device to facilitate removal of No. 2 platen and attachment of No. 3 platen



(Below) The component immersed in a water tank for an air test at 40 lb/in² of the coolant jacket and the sealing of injector sheaths



remove about $\frac{1}{16}$ in stock, and at finishing height. Roughing and finishing spindle speeds are 41 r.p.m. and 86 r.p.m., and the table feed is 12 ft/min. This gives a table cycle of 16 minutes and a production rate of one completed component in 8 min. To conform to the line cycle time of 10 min the table is automatically stopped twice each revolution for component servicing. The finished height of the component is held to a tolerance of 0·0005 in in view of its importance to subsequent operations, such as valve seat machining, at other stations on the line.

Manual transfer down a roller track brings the head, cover face uppermost, to an Archdale radial drill. It is pushed into a fixture, side and end located from cast pads, and clamped up by two air cylinders operating at right angles. The fixture has a hinged bush plate and two holes are drilled, and subsequently tapped, for the attachment of the No. 1 platen. These holes are positioned so that in a later operation they are opened out to become stud holes.

The platen is bolted to the head, which is then pushed into a roll-over cradle and is delivered, seated on the platen, on the roller track. It is pushed to a turntable section and turned through 90 deg for end loading on to a Cincinnati duplex horizontal miller. The fixture has two retractable plungers which enter the large location bushes in the platen and an interlocking device is incorporated to prevent the latching of the overhead clamping arm until these plungers are fully engaged. The side faces of the head are milled, using Galtona cutters, on an automatic cycle which retracts the spindles to clear the cutters on the return stroke of the table. After unloading, the head is again turned through 90 deg on the turntable, which has an anti-clockwise uni-directional movement, to ensure the component is always presented in the same way.

After transfer along the roller track the head is loaded directly on to a Parkinson 3J horizontal miller, which is sunk 6 in below floor level to bring the fixture height to the track level of 42 in. Here the end faces of the head are gang-milled. The fixture has interlocked clamping and location features similar to those on the previous machine.

Beyond this machine the track height is ramped down to 30 in which is the standard height maintained through the automatic transfer sections of the line. These are arranged in three batteries of machines for dealing with operations on the joint face, on the cover face, and the angled operations for the injector bores.

Six Archdale vertical machines comprise the No. 1 automatic transfer battery. Built to the Company's requirements, they incorporate hydraulic feed cycles that can be arranged to give combinations of fast approach, normal feed for drilling and reaming, slow feed for facing, dwell on a dead stop for

working to accurate depth, and fast return to the starting position. The machine head frames and drive units are designed to accept alternative attachments to suit components of different sizes. These detachable multi-spindle units are of A.E.C. design and manufacture.

The attachment carries two location bars, which have radiused noses for easy entry into the bushes of the platen and the fixture pilot bushes. The upper portions of each bar is encased in a telescoping tube housing a helical spring that serves to clamp the platen and also to strip the platen should it tend to lift with the bar on the return stroke. A bridge-type fixture with attached bush plate is attached to each machine table.

An exception to the general rule occurs at the 4th station where the need for extended pilot bushes when drilling the valve guide holes prohibits the use of a fixed bush plate. Instead, a lifting bush plate attached to the multi-spindle attachment is used. The platen slide rails, angularly grooved for swarf clearance, pass through the fixtures in a continuous length. They are attached to the table and also carry the bottom pilot bushes. Between the slide rails is mounted the transfer bar which is furnished with seven spring-loaded latches. The bar is power actuated and as it moves back the latches are depressed under the platens, springing up when they clear them. On the transfer stroke, in the opposite direction, the latches abut the ends of the platens and index all components one station through the battery. On each cycle a fresh component is brought into No. 1 station and a fully machined component is moved out from No. 6 station.

Spindle drives run continuously while the line is operating and the individual driving motors are started by push buttons grouped on the control panel at the unloading end of the battery. Additionally, individual stop-and-start buttons are mounted on the table front face of each machine for convenience when setting or for use in emergency. A master control lever, located near the control panel, links the cycle operating levers and when depressed sets the six machines in motion. Once initiated, the cycle of each machine is continued independently and the tools are returned to the starting position. Within the allowed time cycle, therefore, each machine is set to run at its most economical speed and feed. Two movements only are required to initiate the cycle; depression of a push button to index the components and operation of the master control lever to start the machines cycling. This method of transfer and control is common to all three automatic transfer batteries.

The division of machining operations in No. 1 battery is:

Station 1. Spotface valve guide bosses.

Station 2. Drill stud holes half-way through component.

Station 3. Rough machine valve ports, drill dowel holes.

Station 4. Drill push rod holes, ream dowels, drill valve guide holes.

Station 5. Core drill valve guide holes, rough valve throat and valve seat recess.

Station 6. Ream valve guide holes, finish valve throat and valve seat recess.

On leaving No. 1 battery the component is slid on to a hardened guide rail track and a No. 2 platen, drawn off its roller type return track, is dowel-located on the joint face and secured and latch-clamped to cored holes in the end faces. It is then pushed into a roll-over cradle on a turntable base, inverted, and the service bolts are removed to release the No. 1 platen. After swinging the cradle through 90 deg, No. 1 platen is lifted clear on a hinged portion of the cradle to bear on rollers from which it is slid on to its return track. The cradle is swung through a further 90 deg in the same anti-clockwise direction, and the component, seated on No. 2 platen, is pushed along guide rails to the second battery.

Constituting the No. 2 battery are, in sequence, five Archdale vertical drilling machines, an Archdale duplex horizontal drilling machine, and a Pollard 3-way multi-spindle tapper. Operations performed in this battery are:

Station 1. Complete drilling of stud holes (this includes opening out the two tapped service holes for the No. 1 platen).

Station 2. Spotface bolt holes.

Station 3. Rough machine valve spring seats.

Station 4. Finish machine valve spring seats.

Station 5. Drill push rod holes, drill inlet valve restraint holes, drill tapping holes for cover screws.

Station 6. Drill tapping holes in side faces. At this position eight air jets arranged through the vacant top plate of the fixture blow the swarf out of the blind holes for the cover screws, preparatory to tapping.

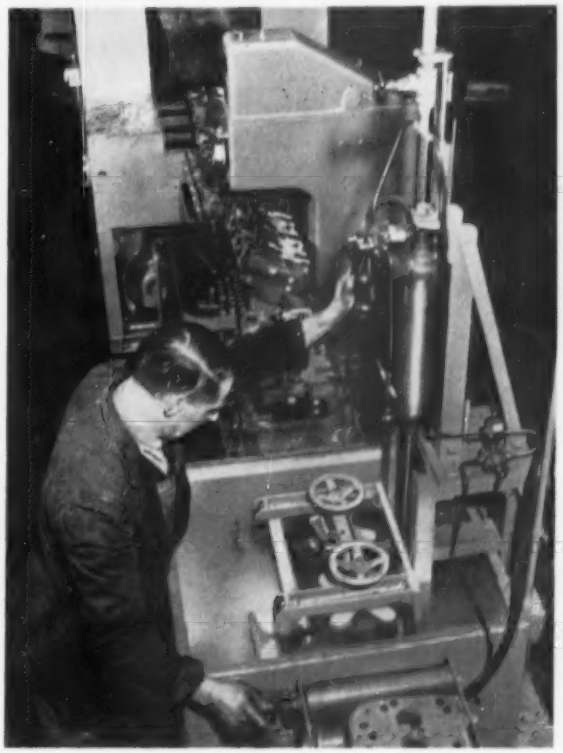
Station 7. Tap all holes in both sides and top face. A metered supply of oil is fed to every tap at each cycle.

On the machines at stations 6 and 7, location of the platen is effected in each instance by a pair of air-operated plungers, clearly visible in the illustrations. The cycle control circuit is interrupted until these plungers are fully entered.

From battery No. 2 the component is pushed on rails to a counterbalanced lifting fixture which clamps it and enables it to be raised easily to a position where the No. 2 platen can be removed. Swarf is shaken off the platen which is then placed on its return track. In its place is affixed a No. 3 platen, which is of wedge section and has an angular face at 20 deg to present the head in the correct attitude for machining the inclined injector holes. By the use of angled platens standard types of vertical or horizontal machines can be used and should any future design requirement necessitate a change of angle, the alteration can be made merely by substituting alternative platens.

In No. 3 battery are five machines; four Archdale vertical

At the end of the cylinder head line are stations for washing, pressing in the copper injector sheaths, and pressure testing for porosity



drilling units and a special 6-spindle tapper designed and built by the Company. Machining operations are performed in the following sequence:

Station 1. Drill three holes for injector sheaths.

Station 2. Drill three holes for injector nozzles and six holes for injector studs.

Station 3. Core drill injector sheath holes.

Station 4. Finish ream injector sheath holes. At this position an automatic air blast blows swarf out of the blind stud holes.

Station 5. Tap six stud holes.

These complete the automatic transfer operations and, with the aid of a second lifting device, the No. 3 platen is removed, swung on a turntable and slid on to its return conveyor. The component is manually transferred on a roller track through the remaining stations. It is pushed into a roll-over cradle and rotated several times in order to tumble out any swarf retained in internal cavities. Valve ports are scoured with an electrically driven, flexible shaft, wire brush, and dust abstracting equipment is provided.

The head is then passed to an Archdale radial drilling machine on which the three print holes in the end faces are core-drilled and reamed to receive the sealing cup plugs, which are then fitted. A second Archdale radial drilling machine is sited alongside for emergency operations on components not completely machined as a result of the occasional breakage of a drill, reamer or other tool. The provision of this machine can obviate the necessity to stop the line in order to replace a single tool.

Next the head is conveyed on a power-driven belt through a Dawson washing machine. In this it is subjected to sprays of a hot alkaline wash from a series of jets. The solution is maintained at a temperature of 100 degF and is circulated at a pressure of 18 lb/in^2. From the washing machine the component is discharged on to the roller track directly adjacent to the closely sited Hare 7½ ton hydraulic press on which the copper sheaths for the fuel injectors are pressed into position. An inclined fixture table supports the component for the vertical insertion of the sheaths. These items are pressed in only; there is no expanding operation.

The final operation is an air pressure test at 40 lb/in^2 of the coolant jacket. On equipment designed and built by the Company, the component is loaded into a pivotally mounted test cradle and two easily applied clamps seal eight orifices in the joint face. Compressed air is introduced into the coolant jacket and the head is then lowered and completely immersed in a tank of water which has an addition of a chromate rust inhibitor. While submerged the head is examined for air bubbles, the presence of which would indicate either porosity of the casting or lack of tightness around the sheaths. The cradle is turned over for inspection from both faces and to facilitate this work a powerful light is incorporated in the base of the tank. After this test the head is placed on a table for final inspection and subsequently is passed through an oil-misting booth of the type described in the casing line. It then leaves the line for assembly or storage.

A problem endemic to automatic transfer lines is the removal of swarf. Unless this is cleared expeditiously and continuously tools may be clogged, fixtures choked, and transfer and location mechanisms obstructed. On the cylinder head line this problem has been solved effectively by the use of shaker type trough conveyors arranged below the apertured tables of the machines, as may be seen in the illustration of the slide rails and transfer bar. The swarf falls through the apertures and various deflectors and scrapers are strategically located to assist the process as the components on their platens are transferred through the battery of machines. Manual servicing is reduced to a minimum. Swarf is tipped from detached platens into the trough and roll-over cradles discharge directly into it.

Three longitudinally arranged conveyors are provided, one for each automatic transfer battery. No. 3 delivers into No. 2 and No. 1 and No. 2 both deliver into a transversely arranged inclined conveyor that carries the swarf up to a suitable level and discharges it into a wheeled container. The inclined swarf conveyor, shown in the view of the platen return conveyors between batteries No. 1 and No. 2, operates at an angle of 10 deg.

To provide the necessary rigidity, the troughs are of extruded light alloy of 6 in × 3 in channel section and ¼ in thick. Each conveyor trough it mounted on links, with torsionally resistant Metalastik rubber bushes at each end, above heavy and rigid support blocks, and is energized by an eccentric type plunger pump driven by a ½ h.p. electric motor. The pump delivers 1,200 to 1,500 impulses per minute and the effective stroke can be adjusted from zero to $\frac{3}{16}$ in by a relief cut-off device to vary the speed of conveyance. As a maximum, the system can handle 10 cwt of swarf per hour, but on the cylinder head line it has to deal, on the average, with only 66 lb per hour.

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

JANUARY

Birmingham

Tuesday, 24th January, 6.30 p.m., in the James Watt Memorial Institute, Great Charles Street, Birmingham. Paper: "Front Suspension and Tyre Wear," by V. E. Gough.

Derby

Monday, January 16th, 6.15 p.m., in the Rolls-Royce Welfare Hall, Derby. James Clayton Lecture by Dr. E. A. Watson, entitled "Fuel Control and Burning in Aero Gas-Turbine Engines."

Derby

Monday, 30th January, 7.15 p.m. Joint meeting with East Midlands Branch in the Rolls-Royce Welfare Hall. Paper: "Some Engineering Problems in High-Speed Flight," by R. F. Creasey.

North-Western

Tuesday, 24th January, 7.15 p.m. in the Liverpool Corporation Transport Offices, 24 Hatton Gardens, Liverpool, 3. Paper: "The Application of Reinforced Plastics in the Manufacture of Vehicle Bodies and Components," by D. S. Mahon.

Western

Thursday, 26th January, 6.45 p.m., in the Royal Hotel, Bristol. Paper: "Commercial Vehicle Structures," by P. Brunton.

FEBRUARY

London

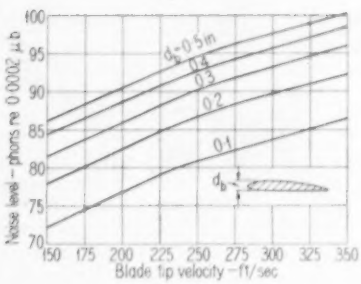
Tuesday, 14th February, 5.30 p.m., at 1 Birdcage Walk, Westminster, S.W.1. Paper: "The M.I.R.A. Proving Ground," by Dr. A. Fogg (Member).

Coventry

Tuesday, 7th February, 7.15 p.m., in the Grosvenor Room, Leofric Hotel, Coventry. Paper: "The M.I.R.A. Proving Ground," by Dr. A. Fogg (Member).

Luton

Monday, 13th February, 7.30 p.m., in the Assembly Hall, Luton Town Hall. Paper: "The Application of Plastics to the Manufacture of Automobile Bodies and Components," by D. S. Mahon.



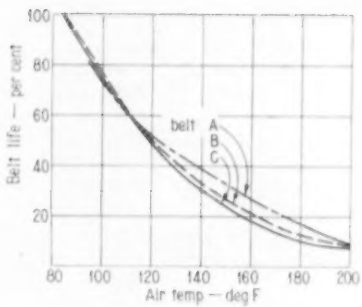


Fig. 1. Left: effect of blade tip velocity and blade thickness on noise

Fig. 2. Right: effect of air temperature on fan belt life

FAN POSITION

J. L. Koffman, Dipl.Ing., M.I.Loco.E.

Theoretical Analysis Shows Advantages in Having the Fan in Front of the Radiator

THE conventional position of the cooling system fan, that is, between the engine and radiator, is adopted principally because of considerations relating to the layout of the drive. However, this arrangement is not ideal and a re-assessment of installation practices is desirable because of current trends towards increased engine power output and higher cooling air velocities, which call for increased fan-speeds and consequently lead to higher noise levels. Such a re-assessment would probably be most advantageous so far as underfloor engines are concerned. With this layout, the radiator is usually mounted as a separate unit, and the fan can be positioned either upstream or downstream of the radiator without undue complication so far as the layout of the drive is concerned.

Consideration of the fan design procedure[1] shows that, generally, the value of air density ρ should be as low as practicable, since this will ensure that, for a given performance, the fan tip velocity U_t also can be kept as low as possible. For a given tip velocity, the pressure rise induced by the fan is proportional to the air density at the fan, and currently, it is considered that the maximum tip velocity should be limited to about 250 ft/sec to keep noise to a minimum. The relation between the variables concerned will be illustrated with regard to typical, heavy duty vehicle design parameters. An analysis of a number of heavy truck and fighting vehicle cooling systems shows that the ratio of total fan area to radiator area varies between 0·45 : 1 and 0·75 : 1, with 0·6 : 1 as a fair average. Thus for a radiator of 1 ft × 1 ft, the fan tip diameter D=0·875 ft. The following calculations are for a system in which the fan has to maintain a flow to satisfy the requirement that the pressure coefficient shall be:

$$\Psi = 2\Delta p/\rho U_t^2 = 0{\cdot}25$$

where Δp lb/ft² is the pressure rise, and the discharge coefficient is

$$\phi = C_m/U_t = 0{\cdot}25,$$

where c_m ft/sec is the air velocity through the area swept by the fan blades. Both these requirements can be met by well designed fans installed in vehicles, although they are close to the practicable limit[1]. As a first approximation, the fan hub diameter is obtained from:

$$d/D = \sqrt{0{\cdot}8\Psi} = 0{\cdot}448$$

so the hub diameter d=0·392 ft, and the fan blade area is 0·78 ft². At an ambient air temperature of 85 deg F, ρ = 0·002265 lb-sec²-ft⁴; consequently, the nominal pressure rise induced by the fan is $\Delta p = 0{\cdot}25 \times 250^2 \times 0{\cdot}002265/2$ = 17·55 lb/ft² or 3·42 in W.G.

The axial velocity of the air through the fan is theoretically $c_m = \phi \times U_t = 0{\cdot}25 \times 250 = 62{\cdot}5$ ft/sec. However, this value is reduced because of the recirculation that takes place through the gap between the blade tips and cowl. With a gap s=0·030 in, the relative gap is $s/R = 0{\cdot}030/5{\cdot}3 = 0{\cdot}00567$; so, with a throttling coefficient $\sigma = \phi^3/\Psi = 0{\cdot}25$, the volumetric efficiency[1] of the fan is $\eta_v = 0{\cdot}93$. Consequently, the air flow through the radiator amounts to $V = 0{\cdot}48 \times 62{\cdot}5 \times 0{\cdot}93 \times 60$ = 1,675 ft³-min/ft². With a $3\frac{7}{8}$ in deep, continuous gill and tube matrix, with eight tube rows, the radiator should be capable[2] of dissipating 1,750 B.Th.U./ft²-min-100 deg F abs. If the cooling system is pressurized to 10 lb/in², and the coolant temperature drop through the radiator is 19 deg F, the temperature difference $T.D. = 239{\cdot}5 - (85 + 9{\cdot}5) = 145$ deg F, so the heat dissipation is $Q = 1{,}750 \times 1{\cdot}45 = 2{,}540$

Fig. 3. If the fan is mounted upstream of the radiator, the flow at the matrix may tend to be disorderly, as shown here

B.Th.U./ft³-min-145 deg F abs. Since, for dry air at 85 deg F, 1 B.Th.U. increases the temperature of 57·15 ft³ of air by 1 deg F, the temperature of the air flow through the radiator is increased by $\Delta t = 2{,}540 \times 57{\cdot}15/1{,}675 = 86{\cdot}5$ deg F.

In the case of a fan mounted downstream of the radiator, where $\phi = 0{\cdot}25, \Psi = 0{\cdot}25, U_t = 250$ ft/sec and the air temperature rise through the radiator is 86·5 deg F, the air velocity into the radiator is reduced to 1,455 ft³/min, or 24·25 ft³/sec. The amount of heat dissipated is reduced to $Q = 1{,}560 \times 1{\cdot}45 = 2{,}260$ B.Th.U./ft³-min-145 deg F abs, while the actual temperature rise is $\Delta t = 2{,}260 \times 57{\cdot}15/1{,}455 = 89$ deg F. Thus the heat dissipating performance is reduced by 11 per cent. Since the heat dissipation of radiators of the type considered here[3] is proportional to the 0·742 power of air velocity, to make good that loss of performance it would be necessary to increase the fan speed to 1·15 times the original value, that is, to $U_t = 288$ ft/sec.

The noise emitted by a fan is principally a function of the blade thickness d_b, air density ρ, and the square of the blade tip velocity, the noise level being given approximately by:

$$L = 20 \log [4{\cdot}9 \times 10^8 \rho d_b (U^2_t/x)] \text{ phons},$$

where x is the distance measured from the source of noise, metric dimensions, m and kg, being used throughout. In practice, the noise level is slightly higher than that given by the above equation; this is because of high frequency blade vibrations[3]. According to the data plotted in Fig. 1, for air at N.T.P., an increase from 250 to 288 ft/sec, tip-speed raises the noise level by 1 to 1·25 phons, and the fundamental frequency is given by the fan speed, in rev/sec, multiplied by the number of blades. It should be noted, however, that if the fan is placed downstream of the radiator, the density ρ is decreased, and this tends to lower slightly the noise level.

Similar calculations carried out for other conditions also indicate the desirability of mounting the fan upstream of the radiator. Another reason for this preference is illustrated in Fig 2, which shows the effect of air temperature upon fan belt life. The tests were carried out on three different types of belt; although, in terms of life, the results varied widely, there is a close similarity when they are plotted in relative terms. The belt runs through the high temperature zone directly downstream of the blades for only a fraction of the total running time, and the average operating conditions do not call for a continuous development of full power output for much of the running time; nevertheless, the adverse effect of placing the belt drive downstream of the fan is clearly shown.

However, with an arrangement of this type, difficulties might be experienced under very dusty conditions, particularly if fans with blades of constant width set at a constant angle from root to tip are employed. With these, the air velocity is approximately proportional to the blade radius; in addition, the air leaving the fan follows a spiral path, unless steps are taken to prevent this. The disorderly flow conditions resulting from the use of a 21·5 in diameter fan, placed some 4·5 in upstream of a 2 ft 6 in by 1 ft 10 in radiator, are shown in Fig. 3, and the air velocity at the radiator face is shown in Fig. 4.

An example of severe erosion encountered in very dusty conditions is illustrated in Fig. 5, and it can be seen that the areas of greatest damage coincide with the shaded areas of Fig. 4. The fan also suffered severely, Fig. 6, the damage due to erosion being almost directly proportional to the circumferential velocity of the blade elements and the axial

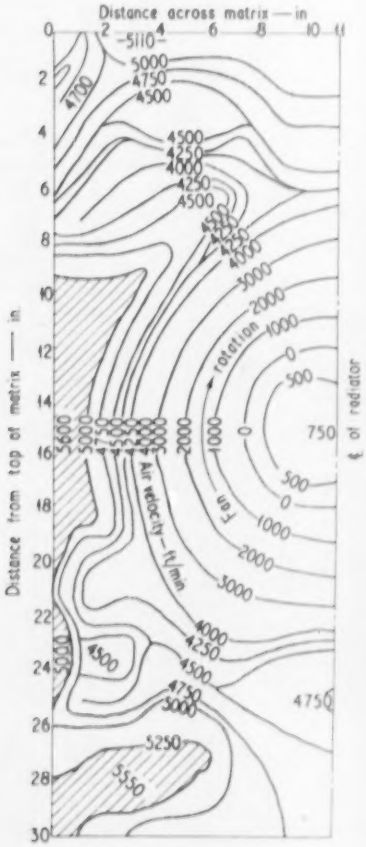


Fig. 4. Left: air velocity distribution at radiator

Fig. 5. Below: erosion, due to heavy dust content of the air, on a quarter of the area of a radiator

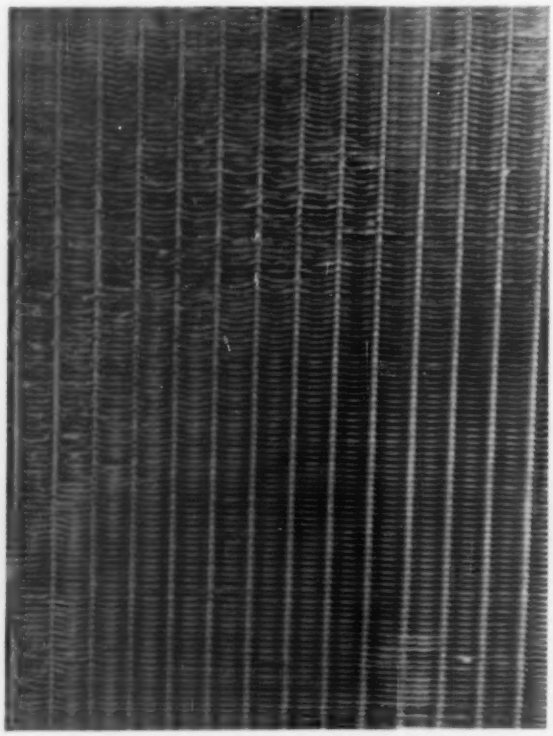
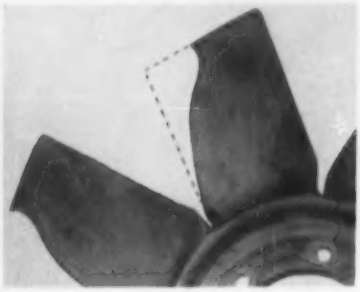


Fig. 7. Left: forward-mounted fans on a heavy tractor

Fig. 6. Below: fan blade erosion



velocity of the air. This is because, with fans of this type, the dust concentration increases as the blade radius, and the energy released by the impact between the dust and the blade is proportional to $mv^2/2$, where v is the relative velocity between blade edge and dust particle.

It is therefore desirable to ensure, by suitable fan blade design[1], that the velocity is uniform. It is also desirable that the air should not have an unduly large swirl component when it reaches the radiator. This aim can be attained by the provision of contra-vanes upstream of the fan or straighteners downstream of it. These measures are particularly desirable when the fan is mounted close to the radiator. In the design of a certain heavy tractor, the relative merits of different layouts were carefully considered and it was decided that the fans should be installed upstream of the radiator. The design is shown in Fig. 7. This layout improved the range of vision of the driver, as compared with more conventional arrangements, since the bonnet height could be reduced towards the front. In addition both belts and fans are readily accessible.

The illustrations are Crown Copyright reserved, and are reproduced by permission of the Controller, H.M. Stationery Office.

References

1. J. L. KOFFMAN, "The Design of Automobile Fans," *Automobile Engineer*, Jan., 1955.
2. J. L. KOFFMAN, "Liquid Cooling," *Automobile Engineer*, Feb., 1954.
3. J. L. KOFFMAN and F. J. H. TUTT, "Fan Noise. Its Effect on Design and Performance," *Gas and Oil Power*, April and June, 1955.

PATTERNS CAST IN EPOXY RESIN

REPLICAS of master patterns are often required in foundries. They may be made in wood or metal as separate patterns, or in metal, plaster or plastic stone, cast integrally with a plate. When made in wood or metal, whether as separate patterns or as "plated" patterns, the labour costs are high, but are substantially reduced when cast resin patterns are made. A further advantage of this process is that epoxy casting resin will give perfect reproduction of a mould surface.

If a mould is made from a master pattern in plaster or low-temperature sprayed alloy, the replica cast in resin will be an accurate reproduction in detail and dimension, for this casting resin sets at room temperature and the fillers used reduce the slight contraction to a negligible amount. The process of making a resin casting is very simple. It merely entails the mixing of a given percentage of hardener with the resin and the addition of filler to suit the work in hand.

Generally speaking, resin is suitable for casting any kind of split pattern; in other words, a pattern where the upper horizontal face is not a moulding face. This limitation is set because resin/filler/hardener mix is bound to contain entrapped air, and some bubbles will migrate to the upper surface and give rise to pin-holing. It may be possible to obviate this by various methods, such as the addition of filler to resin the day before use, vacuum treating the mix before casting, casting a closed mould at an angle to reduce the area of pin-holing, or by arranging a riser if it can be effectively positioned to include most of the entrapped air.

A cast resin pattern will require little or no machining. If the mould has been perfect and the amount of filler has been suited to the job, there should not be any imperfections on the face. Should a pattern need to be repaired or altered, a "putty" or paste of resin and filler plus hardener can be used to fill or build up. The resin is an almost universal adhesive. It adheres to metal and to several cured resins, providing any trace of grease or wax is removed. The stripping qualities of resin patterns are good and are said to improve with use. The low thermal conductivity of the material prevents condensation or sweating on the surface when warm sand has to be used. The cost of filled resin is round 4s. to 6s. a pound, depending on the proportion of filler added. Although the capital cost for equipment is less than £1, the chief claim made for this new pattern-making material is the reduction in costs through large savings in labour on finishing time. "Araldite" epoxy resins, developed by Aero Research Limited, Duxford, Cambridge, are resistant to chemical attack, especially to attack from alkalis.

Venturi passage air inlet louvres are incorporated at the rear of the Saurer articulated buses operating in Zürich

Cooling Air Flow

The Venturi as a Cooling System Design Aid

THE design of efficient cooling systems is becoming increasingly difficult because of the trends towards increased engine power output and weight reduction. Moreover, modern styling and compact design tend to reduce the space available for the passage of cooling air. It is therefore necessary to make every effort to reduce the pressure losses in the cooling air flow. This reduces the power required to drive the fan, and increases the life of the components of the fan drive. In addition, for a given fan diameter, a reduction in pressure losses enables the fan to be run at lower speeds, and thus reduces the noise level.

Not only is it desirable to keep the friction and shape resistance losses low, but also attention must be given to the fact that substantial losses may be incurred due to reduction of the velocity head. The maintenance of a velocity of 4,005 ft/min, when the air is at N.T.P., requires a pressure of 1 in water gauge. If the air flow is retarded and then accelerated again, part of this pressure might be dissipated in turbulence unless the sections at which changes of velocity occur are carefully designed to reduce these losses to a minimum. From this point of view, the venturi passage is of considerable use particularly so far as louvres are concerned.

According to Bernoulli's theorem, the total energy of flow is represented by the head of fluid H as follows:

$$H = P/\gamma = p/\gamma + h + c^2/2g = \text{constant}$$

where P is the pressure, γ is the specific weight, p is the specific pressure, h the pressure due to elevation, c the velocity of the flow and g the gravitational constant. In other words, the total pressure is equal to the sum of the static pressure, the potential pressure, and the dynamic or velocity pressure. The value of h can be assumed as constant and, since it is relatively small, it can be neglected.

This simplifies the equation to:

$$p_1/\gamma + c_1^2/2g = p_2/\gamma + c_2^2/2g$$

that is $$P/\gamma = \text{constant}$$

or $$P_s + P_d = P_{tot}$$

Thus, neglecting friction and turbulence losses, the various forms of pressure may vary in magnitude, but their sum remains constant. If $h = O$, and the cross-sectional area of a horizontal pipe in which air is flowing increases gradually along its length, the velocity of the flow through it is decreased and, since energy remains the same, the static pressure is increased.

The question that arises is, how rapidly can the velocity be decreased in a diverging passage, or diffuser? Limits are set by the fact that if the flow is retarded too drastically, by a rapid change of section, it separates from the walls, and the resultant energy losses due to turbulence reduce the pressure rise along the passage, which under ideal conditions is given as:

$$\Delta p = (\gamma/2g)\,(c_1^2 - c_2^2)$$

where c_1 and c_2 are the velocities at the entry and discharge ends, respectively. If the velocity distribution curve is as shown at section 1–1, Fig. 1, the velocity distribution curve at 2–2 can be determined by plotting velocity triangles, with the value of c_2 being represented by the hypotenuse, and c_1 and $\sqrt{2g(\Delta p/\gamma)}$ by the other two lines. The resultant plot shows that the velocity distribution curve has a more pronounced peak as the mean velocity decreases, a fact fully verified in practice. This leads to difficulties, since the

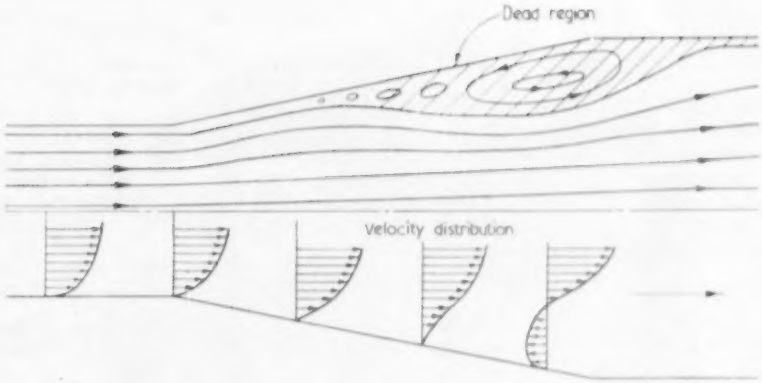


Fig. 2. Diagram showing the nature of flow separation that tends to occur in divergent passages

velocity of the layer of air adjacent to the walls of the tube might eventually be reduced to a level at which the kinetic energy is only just sufficient to meet the static pressure rise requirements. In these circumstances, the layer adjacent to the walls comes to a standstill, while layers that are next to it might even move in the opposite direction. The resultant flow pattern is shown in Fig. 2: the eddies are a major source of loss of energy.

The relation between the inertia, γV^2 per unit area, and the viscous drag, which is proportional to $\mu V/D$, and which destroys a certain quantity of momentum per unit time, is expressed by the non-dimensional Reynolds number,

$$Re = D\,V\gamma/\mu$$

where μ is the absolute viscosity of the fluid in lb/hr-ft, V the velocity in ft/hr and D the passage diameter in ft.

For rectangular diffusers, the diameter D is the hydraulic diameter $D_h = 4\,A/U$, where A is the area and U the periphery of the cross-section. If, therefore, both the momentum and the viscous drag forces are varied in the same proportion, the flow pattern is unchanged.

Another important characteristic of the diffuser is the angle of divergence α. Theoretical considerations[1] based on the results of extensive tests, have shown that similar flow conditions are likely to be encountered provided that the value of $\alpha\sqrt[4]{Re}$ remains the same. This conclusion holds good for Re values of up to 200,000. In addition it has been found that the highest pressure rise is obtainable for $\sqrt[4]{Re} = 150$. This is of considerable importance so far as the determination of α is concerned, and the relevant values are plotted in Fig. 3.

If the diffuser is long enough, the velocity of flow is reduced to a level at which separation is inevitable. To avoid this, it is necessary to limit the ratio of exit to entry area, A_2/A_1. The approximate limits, for $\alpha = 5$ deg to 120 deg are given by the following empirical expression derived from published data:[2]

$$A_2/A_1 = 3 - 0{\cdot}1\alpha$$

A curve defining these limits is illustrated in Fig. 3. Short diffusers are necessary for operation at high Reynolds numbers, since the point of separation moves upstream as the Reynolds number is increased.

The determination of diffuser efficiency is based on the equation of continuity:

$$A_1\rho c_1 = A_2\rho c_2$$

where $\rho = \gamma/g$ is the fluid density.

From this it follows that:

$$c_2 = c_1\,A_1/A_2 = c_1\,M$$

and from Bernoulli's equation the change of velocity head is given by:

$$\Delta P_v = (\gamma c_1^2/2\,g)\;(1 - M^2)$$

while the actual rise of static pressure is $p_2 - p_1$ and the static pressure efficiency is:

$$\eta_s = (p_2 - p_1)/\Delta p_v$$

With carefully designed diffusers η_s can be as high as 0·8 to 0·9, while values of 0·7 to 0·8 can generally be expected with properly designed layouts of practical form. However, diffusers of circular cross-section are more efficient than rectangular ones in converting velocity into pressure,[3] and this should be taken into consideration. A form of passage in which pressure losses are low can be obtained by the use of a diffuser with a converging nozzle, having an included angle of about 20 deg, in conjunction with a converging-diverging nozzle resembling a venturi passage of the type used for flow measurement. However, if the resultant passage is too long, an entry based on the shape of the International Standards Association flow-nozzle meter,[4] as shown in Fig. 4, can be employed.

To illustrate the design procedure for venturi-type grilles the following example will be used. A 100 h.p. C.I. engine installation requires a maximum cooling air flow of 2,500 ft³/min, and the inlet louvre area must be limited to 1 ft². The passages are to be $\frac{1}{2}$ in wide at the narrowest section and each louvre has to be 1 ft long. With the inlet designed on the lines illustrated in Fig. 4, the free passage area will be: $A_1 = 1 \times 0{\cdot}5/0{\cdot}9 = 0{\cdot}555$ ft², and the resultant air velocity $V_1 = 2{,}500 \times 60/0{\cdot}555 = 270{,}000$ ft/hr. The hydraulic

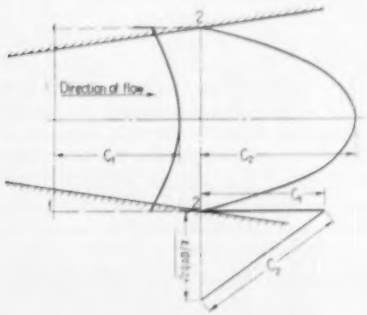


Fig. 1. Left: velocity distribution in a divergent passage

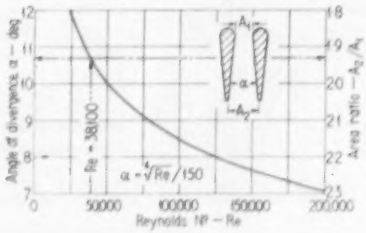


Fig. 3. Centre: angles and area ratios of divergent passages

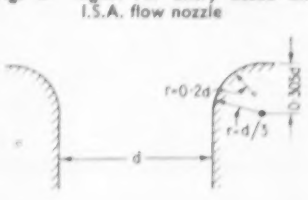


Fig. 4. Right: Air entry based on I.S.A. flow nozzle

diameter of each passage is $4\ A/U = 4 \times 1 \times 0{\cdot}0417/2{\cdot}0834 = 0{\cdot}0797$ ft. Since there will be $12/0{\cdot}9 = 13$ passages, the Reynolds number is:

$$Re = 0{\cdot}08 \times (0{\cdot}07651/0{\cdot}043 \times 270{,}000) = 38{,}500.$$

Moreover $\sqrt[3]{Re} = 14{\cdot}02$, so the diffuser angle will be $\alpha = 150/14 = 11$ deg, approximately. If the length of the diffuser portion of the passage is limited to 2 in, the width at the outlet will be 0·884 in. This means that the area ratio will be $0{\cdot}884/0{\cdot}5 = 1{\cdot}765$ whereas, ideally, the area ratio should be 1·93, Fig. 3. If none of the velocity head is recovered, the pressure lost will be:

$$P_v = \frac{0{\cdot}07651 \times 75^2}{2 \times 32{\cdot}17}(1 - 0{\cdot}56^2) = 46 \text{ lb/ft}^2, \text{ or } 8{\cdot}85 \text{ in W.G.}$$

On the assumption that the diffuser efficiency is 0·75, this value is reduced to 2·21 in, W.G., which corresponds to the head that would be obtained with a vehicle speed of 67·5 m.p.h. An example of the employment of air inlet louvres of this type, with centre lines of the venturi passages slightly curved is shown in the half tone illustration.

References

1. J. NIKURADSE, "Untersuchung über die Strömung des Wassers in Konvergenten und divergenten Kanälen," Berlin, *V.D.I.*, 1929, Bulletin 289.
2. J. POLZIN, "Strömungsunfersuchungen an einem ebenem Diffusor." *Ing. Archiv.*, Vol. 11, 1940, pp. 360-385.
3. A. J. BUCHI, "Turbo Charging and Gas Turbines," *Journal Am. Soc. Naval Eng.*, Vol. 60, No. 3, Aug., 1949, pp. 360-391.
4. H. ADDISON, "Hydraulic Measurements," p. 142, *Chapman & Hall Ltd.*, London, 1940.

Recent Publications

Brief Reviews of Current Technical Books

Diesel Maintenance

By T. H. Parkinson, M.I.Mech.E., edited by Donald H. Smith, M.I.Mech.E.

London: ILIFFE AND SONS LTD., Dorset House, Stamford Street, S.E.1. 1955. $8\frac{1}{4} \times 5\frac{1}{2}$. 214 pp. Price 12s. 6d.

This, the fourth edition of Diesel Maintenance, is essentially a practical manual. It is published for our associate journal, *Motor Transport*. The author was responsible, in 1930, for much pioneer work in the installation of compression ignition engines in the first all-British oil-engine trucks and buses to be put on the road; since then he has been continuously associated with diesel engine operation. In compiling this book he has had the co-operation of a technical writer of wide experience in this special field.

The opening chapter outlines the history of the modern automotive diesel. Subsequently, there are chapters dealing with planning repair schedules, engine maintenance, injection equipment, adjustment and alignment of engine auxiliaries, testing of reconditioned engines and spare parts. The section on injection equipment occupies about half the total number of pages in the work. Finally two chapters are on garage and workshop layout and the future of the automotive diesel are included. At the back of the book, there is an appendix, giving miscellaneous items of information. The work can be summed up as being a thoroughly practical work of reference, obviously by an author with many years of experience in this field.

Automotive Engines

By William H. Crouse.

New York: MCGRAW-HILL BOOK CO., INC. 1955. $9\frac{1}{2} \times 5\frac{1}{4}$. 518 pp. Price 49s.

A series of five books covering in detail the construction, operation and maintenance of automobiles is published by McGraw-Hill. Automotive Engines is one of the series, which is intended mainly for service mechanics. The author at one time was director of field education of the Delco-Remy Division of the General Motors Corporation, and during the war years wrote a number of technical manuals for the armed forces. After the war, he became Editor of Technical Education Books for the McGraw-Hill Book Co. The first section of the book deals with elementary, fundamental principles and the second gives descriptions of automobile components. Subsequent chapters are entirely devoted to different aspects of engine theory and servicing.

The Sports Car

By Colin Campbell, M.Sc., A.M.I.Mech.E.

London: CHAPMAN AND HALL LTD., 37 Essex Street, W.C.2. 1954. $8\frac{1}{4} \times 5\frac{1}{2}$. 262 pp. Price 30s.

This book is indeed of considerable interest to automobile engineers, as well as to mechanically-minded sports car owners, since, unlike most works on sports cars, it is a serious study of the technical problems met with in the design of this type of vehicle. Nevertheless, the work is not simply a dull textbook of design and the mathematics in it have been kept to a minimum. It is written by a research engineer who has been also a keen competitor in club events for the past twenty years.

After opening with a chapter on the development of the sports car, the author has devoted four chapters, comprising 69 pages, to the engine. The first of these chapters is on cylinder head design, the second on induction and exhaust systems and the third on miscellaneous components. In the final chapter in this group of four, trends of design are discussed, the author comments on the fallacy of a limiting mean piston speed, gives a formula for maximum continuous cruising r.p.m., and deals with other design criteria.

Chapters 6, 7 and 8 are devoted to road holding, suspension and constructional considerations respectively. The next two are on transmission and brakes, while chapters 11 and 12 are devoted to tuning and performance. Finally, future developments are discussed: among these are gas turbines, torque converters and automatic transmission, and internally sprung wheels. A glossary of technical terms is included at the end of the work, but this is mainly for the novice.

Manufacture and Application of Lubricating Greases

By C. J. Boner.

New York: REINHOLD PUBLISHING CORPORATION, 430 Park Avenue. 1954. $9\frac{1}{2} \times 6$. Price 148s.

This is an unusually large and complete volume. It describes fully the structure and theory of lubricating greases and several chapters are devoted to the raw materials, processes and manufacturing equipment. Detail attention is given to lubricants containing specific thickeners and additives, including such new developments as lithium soaps, complex soaps and non-soap gelling agents. The effects of each ingredient or treatment upon the characteristics of the final product are discussed, as also are methods of evaluating these characteristics by either chemical or physical means.

The author, a graduate of the University of Missouri, has been closely associated with every phase in the research, development, manufacture and use of lubricating greases for a period of over 27 years. At present he is technical director and chief research chemist of the Battenfeld Grease and Oil Corporation. He is also a past Chairman of the Kansas City Section of the American Chemical Society.

Fluid Friction Coefficients

By J. R. Finniecome, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., M.Soc.Ing.C., A.M.I.E.E.

Manchester: EMMOTT AND CO. LTD., 31 King Street West. 1954. $7\frac{1}{2} \times 5$. 125 pp. Price 10s.

This is an extremely compact and useful work of reference for those concerned with the design of systems in which fluid friction data are required. The work emphasises the essential factors influencing the fluid friction coefficients in straight pipes of circular cross section. It correlates and presents, in the form of charts, useful information relating to the pressure drop in smooth and rough pipes. The emphasis throughout is on the larger types of system used for carrying steam, water and other fluids in relatively large bulk and over distances measured in feet rather than in inches. A bibliography is given at the end of the book.

Some of the Latest Developments and Design Trends in Trucks, Trailers and Special Purpose Vehicles

GERMAN COMMERCIAL VEHICLES

BECAUSE of the economic incentive provided by an exceptionally good trunk road system in Germany, manufacturers in that country have devoted considerable attention to the development of special purpose vehicles that might almost be described as mobile mechanical handling equipment. Parallel with this trend, there has also been the development of more conventional truck designs, but with the emphasis on high-speed performance, large load-carrying capacity and driver comfort for long distance operations. Trailers are more popular in Germany than in this country, because manœuvrability and obstruction are not serious problems on the wide, straight autobahns.

It will be interesting to see what effect the proposed changes in the regulations with regard to maximum axle loading and overall dimensions will have on German vehicle design. The probability is that, so far as weight and bulk are concerned, design in that country will follow more closely current British practice. In fact, there are signs that movements in this direction are already being anticipated. A number of manufacturers are now offering for the first time underfloor-engined chassis, even for trucks, and forward control cabs. These measures have been taken with a view to obtaining the greatest possible length of load-carrying space for a given overall length. However, British exporters will continue to be at a disadvantage so long as heavy vehicles in this country continue to be restricted to a maximum speed of 20 m.p.h. and our roads continue to be narrow and tortuous, as most of them are now. Perhaps it is not too much to hope that common sense will in the end prevail, so that British manufacturers will be able to meet their foreign competitors on equal terms.

Among the manufacturers that have recently adopted

Magirus Deutz have recently introduced for the first time the forward control cab, illustrated above and below. In conformity with common Continental practice, the beds are optional

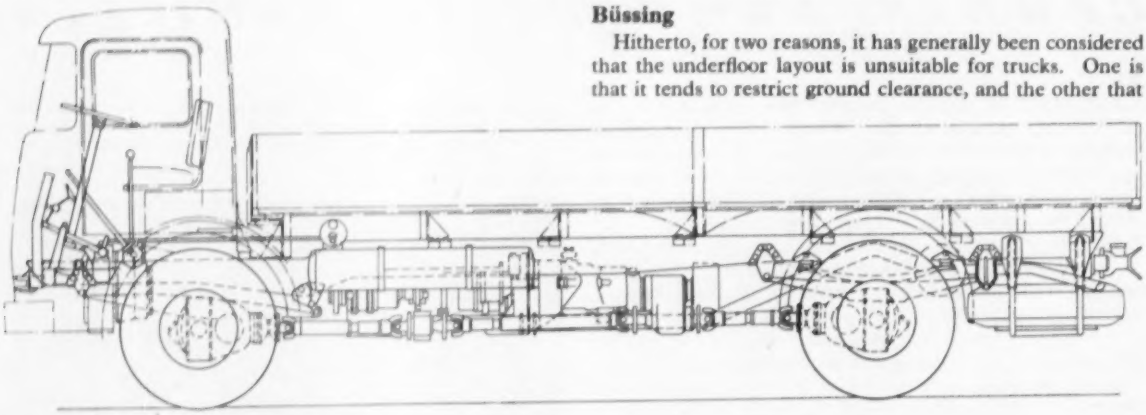
The radiator installation on this cross-country vehicle is typical of the general arrangement employed on all the Büssing commercial vehicle chassis

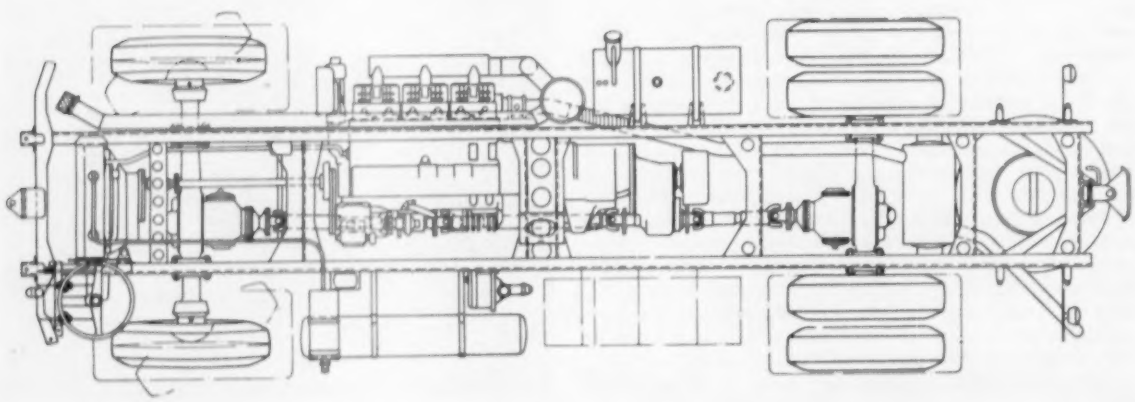
forward control layouts is Magirus Deutz. However, the earlier designs are still offered as an alternative, since many operators still prefer the bonneted engine layout, which gives lower noise level and more room in the cab. The forward control vehicle is designated the type S 7500 Jupiter F. It has a gross vehicle weight of approximately 14 tons and its payload is about 7½ tons. The engine is the air-cooled, eight-cylinder, 170 b.h.p. unit made by the same manufacturers. With the forward control cab, the overall dimensions of the platform space available for the load-carrying body is 19 ft 8½ in × 7 ft 8½ in.

The cab can be supplied with seating accommodation for four or five persons; alternatively, if folding beds are fitted, there is accommodation for two or three seated and two persons lying on the beds. As can be seen from the accompanying illustration, one bed is behind the seat squabs and the other, which is above the first, is hinged on the back of the cab, against which it is stowed vertically when not in use. The seat squabs pivot forwards to give access to the beds, and have vertical ventilation slots in them to add to the comfort of the occupants. Curtains can be drawn over the rear windows of the cab to prevent headlights of following vehicles from troubling the driver and so that the occupants of the beds can sleep more readily during the hours of daylight.

Thermal and noise insulation material is used to cover the engine cowl. Access for filling with oil and checking the level with the dipstick is gained through a flap on the front of the cowl and a similar flap at the back opens to disclose the injection pump and controls. For extensive servicing work, the whole of the cab, except the skirt and wing panels, can be hinged forwards. Toe plates are fitted on the front bumper to avoid damage to the paint when the windscreen is cleaned.

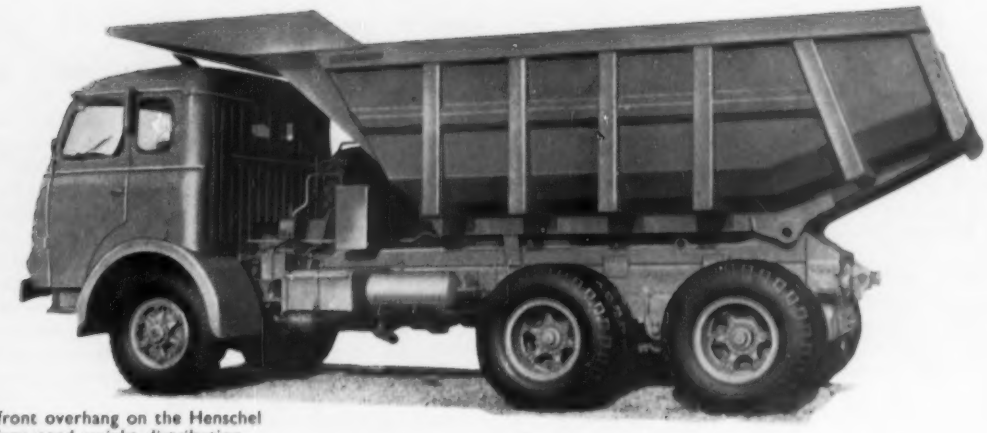
On the Büssing underfloor-engined cross-country vehicle, a transfer box is mounted on the rear of the gearbox and the transmission line is alongside the engine, so as not to reduce the ground clearance





Büssing

Hitherto, for two reasons, it has generally been considered that the underfloor layout is unsuitable for trucks. One is that it tends to restrict ground clearance, and the other that



A large front overhang on the Henschel tipper gives good weight distribution

it limits the scope of the manufacturer in designing certain types of vehicles, notably tippers. However, objections with regard to ground clearance do not appear to be well founded, since Büssing have now added an underfloor-engined cross-country vehicle to their range of trucks of this layout. One advantage of the underfloor arrangement is that it enables the loading platform to be made longer for a given overall length of vehicle. Also, in the cab, the noise level is relatively low, the floor space between the driver and the remainder of the crew is unobstructed and the air temperature can be more readily controlled than if the engine is in a forward position. Thus, there is much to commend this layout for long-distance operation. Accessibility for engine servicing is another advantage claimed for underfloor engines in trucks. In the Büssing cross-country vehicle, for example, the cylinder heads and pistons can be removed readily without taking the engine out of the chassis.

In addition to the cross-country vehicle, Büssing have two rear-wheel drive trucks of the underfloor engine layout. One is the LU7 and the other is the LU11. The principal weights of the LU7 unit are: chassis 8,370 lb, chassis carrying capacity 16,090 lb, total weight 24,460 lb. This vehicle is 22 ft 6 in long by 7 ft 10½ in wide. Its wheelbase is 12 ft 3·6 in and the front and rear track are 6 ft 0¼ in and 5 ft 9½ in respectively. The turning circle is 48½ ft diameter. It is of interest to note that the ground clearance under the gearbox is 15·8 in and the top of the frame is 39¼ in above the ground.

The chassis is powered by the U7, six-cylinder, four-stroke, diesel engine, which is of the precombustion chamber type. At 2,400 r.p.m., the maximum power output of this unit is 130 b.h.p. The swept volume is 6¾ litres, and the bore and stroke are 105 mm and 130 mm respectively. These dimensions give a mean piston speed of 2,047 ft/min at 2,400 r.p.m. A compression ratio of 22:1 has been adopted. The mean effective pressure at maximum power output is 103 lb/in², and at 1,400 r.p.m., when the maximum torque of 311 lb-ft is developed, the mean effective pressure is 114 lb/in². In the dry condition, the engine weighs 1,250 lb. Its overall dimensions are: length 56·9 in, width 55·5 in, height 20·9 in.

A synchromesh gearbox, giving five forward speeds and one reverse, is employed in conjunction with a double-reduction rear axle. Semi-elliptic suspension springs are employed, those at the rear incorporating helper springs. The tyres are 9·00-20 eHD type, single at the front and twin at the rear. Among the chassis equipment and accessories are a coolant temperature gauge and a radiator blind.

The LU11 unit has a total weight of 33,070 lb. Its chassis weighs 10,580 lb and the carrying capacity is 22,480 lb. The overall dimensions are: length 25 ft 7 in, and width 7 ft 10½ in. The wheelbase is 17 ft 11½ in and the front and rear track are 6 ft 3·8 in and 5 ft 8·2 in respectively. A turning circle of 59 ft is quoted. The ground clearance under the clutch housing is 17·1 in and the height of the top of the frame above the ground is 43 in.

This chassis is powered by the U11, six-cylinder, four-stroke, diesel engine, which is also of the precombustion chamber type. The bore and stroke are 122 mm and 155 mm respectively, and the swept volume is 10·87 litres. A power output of 170 b.h.p. is developed at 2,000 r.p.m. The maximum torque is 499 lb-ft at 1,300 r.p.m. At 2,000 r.p.m. the mean effective pressure is 100 lb/in² and at 1,300 r.p.m. it is 113 lb/in². The mean piston speed at maximum power output is 2,028 ft/min and the compression ratio is 21:1. In the dry condition, the engine weighs 1,930 lb. Its overall dimensions are: length 57·1 in, width 53·7 in, height 20·9 in. A dog clutch engagement type gearbox, with six forward speeds and one reverse, is employed. The other equipment of the chassis is similar to the LU7, except that 11·00-20 eHD tyres are fitted.

The specification of the LU11 cross-country vehicle is almost the same as that already described, except that it has four-wheel drive and the chassis weight is 11,680 lb. Accordingly, the load-carrying capacity has been reduced to 21,380 lb, so that the total weight is still 33,070 lb. Despite the four-wheel drive arrangement, the ground clearance under the clutch housing remains the same at 17·1 in, and the frame height also is the same. As can be seen from the accompanying illustration, the transfer box is bolted to the rear end of the gearbox. A short propeller shaft takes the drive to the rear axle and a two-stage drive, with an intermediate bearing mounted on the crankcase, is taken alongside the engine to the front axle. The bracket that carries the eye at the forward end of the front suspension spring is appreciably higher than that at the rear end, which is shackled. This arrangement has been adopted simply to enable common front and rear axles to be employed, with the propeller shafts at the same angle. The effect of the inclination of the springs on the steering is negligible because of the relatively long wheelbase.

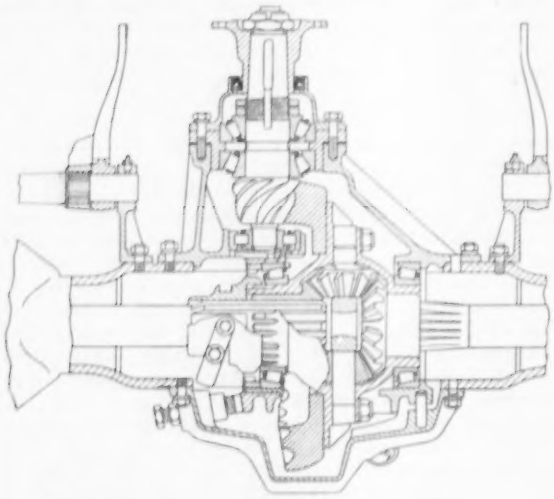
At the rear of the vehicle, a slider block is employed instead of a shackle at the trailing end of each spring. The second leaf of the spring is turned down behind a retainer bolt under the block. This prevents the end of the spring from jumping out under rebound conditions when the vehicle is travelling over rough terrain. The pads in these slider blocks are of hardened steel; the manufacturers specify that they should not be lubricated, because lubricant

tends to collect abrasive matter and cause rapid wear.

As in the other Büssing vehicles, a well designed radiator installation is employed. The fan and radiator are fully cowled, and the cooling system is pressurized to 0·35 atm. The radiator block is 29½ in wide by 20 in deep. All the Büssing chassis are equipped with the Vogel pneumatically-operated lubrication system. In this vehicle, a button on the dash is pressed until a green lamp beside it is illuminated to indicate that the lubricant under pressure has reached the most remote parts of the system.

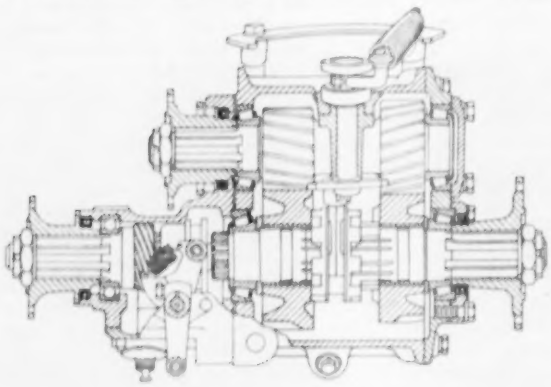
Henschel

Henschel and Sohn, G.m.b.H., of Kassel, have recently introduced a new tipper. The overall length of this vehicle, excluding the overhang of the tipper body at the rear, is 23 ft 6 in, and its overall width is about 8 ft 2 in. Between the front axle and the foremost of the rear pair of axles, the distance is 11 ft 1½ in and between the rear pair of axles it is 4 ft 7 in approximately. With the cab, the chassis weighs 18,000 lb, and fully laden the vehicle weighs 62,700 lb. The payload is 35,200 lb. To obtain a good weight distribution, the cab-over-engine layout and a large front overhang, approximately 5 ft 10½ in, have been adopted. By placing on the front wheels an unusually high proportion of the weight of the tipper load, it has been possible to obtain a relatively large pay load without exceeding the legal limit on the two rear axles.



The differential lock in the single-reduction rear axle of the Henschel HS100AK can be actuated when the vehicle is in motion

The two-speed transfer box of the Henschel HS100AK has a pre-selective control. Preselection is effected by loading a spring, which unloads to change the speed only when the drive is interrupted



Twin tyre equipment is employed on each rear axle. On each side, a single semi-elliptic spring is mounted with its centre over the end of a cross tube, on which it is pivoted. The ends of the spring project into slider blocks above the two driven axles. Brake and drive torque and thrust are taken by adjustable rods, with ball joints at their ends. At each side, one of these rods is connected to a bracket under the end of each axle and to another bracket under the central cross tube that carries the spring. Another rod is connected between the top of the worm housing on each axle and a bracket on a frame cross member above the tube that carries the spring.

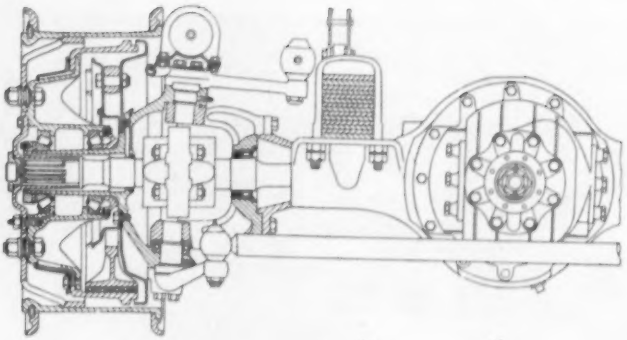
The tipper body is of Meiller construction, and is pivoted at the rear of a sub-frame. The side members of this sub-frame are secured, by U-bolts, near their front ends on top of the chassis frame. Two plates welded on each side of the sub-frame extend downwards and are bolted to the chassis frame side members to strengthen the attachment just forward of the pivot about which the body tips, and a similar arrangement is employed at the extreme rear end of each side member.

This arrangement is employed on most of the Meiller tippers, which are fitted to an extremely wide range of vehicles, from the 30 cwt class upwards. It has the advantage that all the tipper gear is self-contained on its own frame, and is, therefore, easy to assemble. Moreover, the tipper frame helps to spread the load over the chassis frame and forms a useful reinforcement.

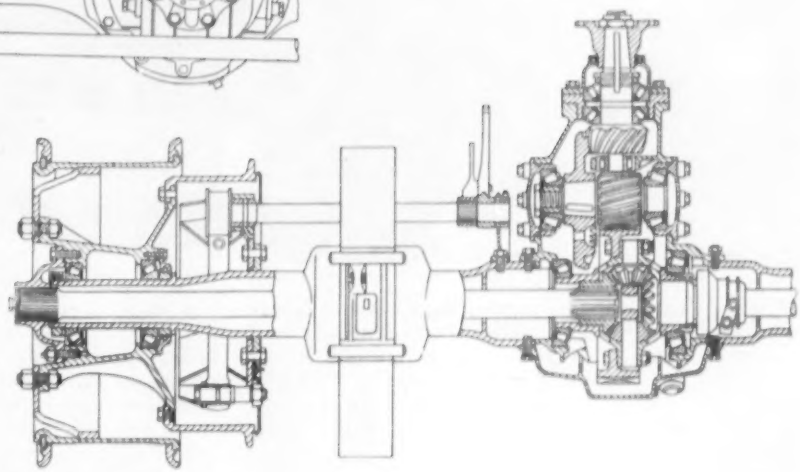
The main components of the tipper sub-frame are the two channel section side members. A cross tube at the rear end forms the pivot for the body. Another cross tube on the sub-frame, approximately midway between the two rear axles, forms the pivot for the lower link of the knee-joint type actuating mechanism. This lower link is forked to receive the end of the ram of the hydraulic jack, and the arms of the fork are connected to the double upper link. A cross member under the tipper body carries the upper end of the double link. The closed end of the jack cylinder is ball-jointed on a tubular cross member between the side members of the sub-frame. A micro-switch on another small cross member contacts the jack, when it is in the fully extended position, and cuts out the hydraulic power. Three large rubber-to-metal bonded, sandwich type buffers are interposed on each side between the tipper body and the sub-frame. They cushion the shock at the end of the retraction motion. Guide brackets, welded under each side of the frame of the tipper body, extend down beside the outer faces of the sub-frame side members to centralize the body as it is lowered.

The chassis is powered by the Henschel type 520 DO engine. This is a six-cylinder unit that develops 180 b.h.p. at 2,000 r.p.m.; the maximum torque is 553 lb-ft at 1,200 r.p.m. Its bore and stroke are 125 mm and 150 mm respectively, and the displacement is 11·045 litres. From the six-speed ZF AK 6-75 gearbox, the drive is transmitted to a ZF VG 500, two-speed transfer box. Differential locks are incorporated in both the front and rear axles.

Henschel have also introduced a new vehicle designed for operation on cross-country routes as well as on normal roads. It is the HS 115 model. The cab-over-engine layout has been adopted to give maximum carrying capacity behind the cab. In general, the arrangement of the mechanical components is similar to that employed on the earlier four-wheel drive vehicles, the HS 100A and HS 100AK models.



In the Henschel HS100AK, four-wheel drive tipper, most of the components of the front and rear axles are common



The Henschel HS115 four-wheel drive vehicle has front and rear axles of the double-reduction type each of which incorporates a pneumatically-actuated differential lock

A six cylinder, 6·12 litre diesel engine is employed. It is the 522 DP model, with a bore and stroke of 100 mm and 130 mm respectively, and it weighs 1,045 lb. The maximum power output is 125 b.h.p. at 2,500 r.p.m. A 130 b.h.p. petrol engine is also offered as an alternative. A ZF AK 5-33 gearbox is employed in conjunction with a preselective, two-speed transfer box. In the HS 100 models fitted with this transfer box, the two-speed control is of the mechanical type, but in the HS 120 N and HS 115 models a pneumatically-operated control is employed. When the control is actuated, it simply loads a spring, and the speed-change is not effected until the drive is interrupted, by releasing momentarily the accelerator pedal, to enable the spring to unload. Both boxes are of the constant mesh type and have helical gears to give quiet running.

Most of the components of the front and rear wheel drive units are interchangeable. Each unit has a double-reduction gear. The first reduction is by a spiral bevel pair, with the helical spur pinion of the second reduction mounted in the centre of the crown wheel. This helical pinion drives a gear bolted to a flange round the differential cage. The differential gear in each axle can be locked separately. Both the differential locks and the front wheel drive throw-out gear can be actuated while the vehicle is in motion. Single tyre equipment is employed both at the front and at the rear so that the wheels run in the same track.

An earlier design is the four-wheel drive, HS 100AK, which is a three-way tipper version of the HS 100A, four-wheel-drive truck. A traditional, bonneted engine layout has been adopted and since this places the load further aft, twin tyre equipment is employed on the rear axle. The engine is the 5·43 litre 512 DJ model, which has six cylinders and a bore and stroke of 96 mm and 125 mm respectively. It develops 105 b.h.p. at 2,400 r.p.m. and its maximum torque output is 250 lb-ft at 1,300 r.p.m. The compression ratio is 15·6:1. In the dry condition, the engine weighs 970 lb.

Henschel manufacture this special vehicle for the transport of structural steel sections. The cab is centrally placed in a high position at the front so that the vehicle can be symmetrically loaded

An interesting special vehicle for the transport of rolled steel joists and other heavy components of relatively great length has also been introduced by Henschel. The unusual feature of the vehicle is that the cab is mounted fairly high up at the front, and the load is carried on each side of it, as shown in the illustration. Not only does this allow the full length of the vehicle to be used for carrying the load, but also, in the event of an accident, the lengths of iron that comprise the load do not shoot forwards through the driver's cab and injure the crew. It also enables the vehicle to be laden symmetrically about its longitudinal axis; whereas, if the cab had been placed on the offside, symmetrical loading would not always be possible.

The length of the load that can be carried, including a 12½ ft overhang from the rear of the vehicle, is about 152 ft.

The Unimog S is a light-weight, four-wheel drive vehicle for operation over all types of terrain

Transverse battens on the platform carry the load in such a way that it can be easily handled. Three of the transverse batons on each side are pivoted on the platform at their outer ends and attached to hydraulic jacks at their inner ends. The jacks can be extended to elevate the inner ends of these battens and thus to shoot the load off the vehicle. Before this is done, triangular fenders are fitted in place of the vertical side posts so that the load falls clear of the side of the vehicle. In the illustration, the load on the near-side is shown in its normal position and the vertical side posts are fitted, while that on the far side is shown with the jacks extended for unloading.

Power take-offs are provided at the front and rear of the Unimog S so that the vehicle can be readily adapted for many different types of operation

A 200 b.h.p. engine is installed at the rear of the vehicle. The cab has sliding doors on each side and is fitted with vertical rubber strips in front and behind the doors to protect the paintwork and panels against damage from the load. Another door, hinged on the right-hand side, is fitted in the rear panel so that the second member of the crew can get in and out without climbing over the driver's seat. The seat for the second member of the crew is fitted transversely behind that of the driver.

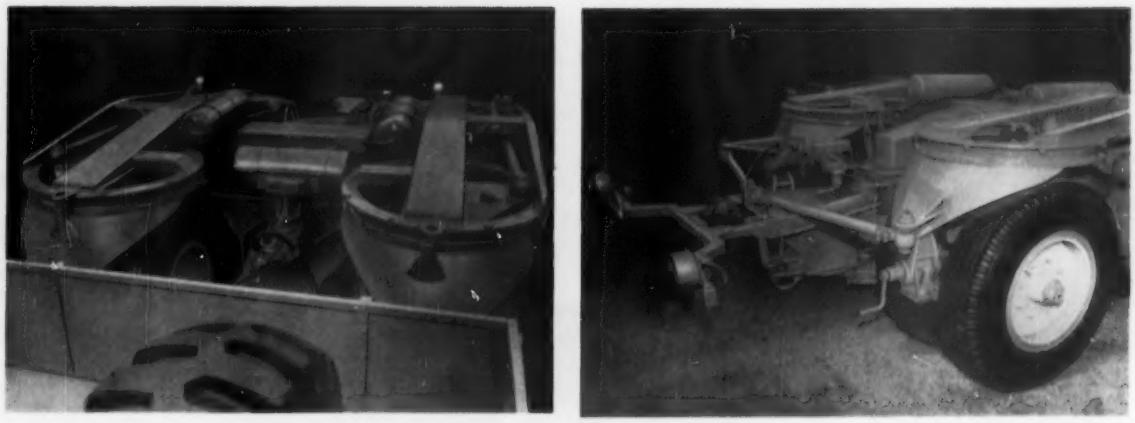
Mercedes Benz

Among many variants of the Unimog vehicle is the recently introduced Unimog S. This is a lightweight vehicle intended for operation over all types of terrain. In this design, the cab-over-engine layout has been adopted and the overall length and the wheelbase have been restricted. These features give the vehicle a relatively small turning circle and a good range of forward vision. Recirculating ball type of steering gear has been adopted and hydraulic dampers are incorporated in the steering system. There are power take-off shafts for driving, for example, snow clearing equipment or compressors for road drills.

A six-cylinder petrol engine with a bore and stroke of 80 mm and 72·8 mm respectively is employed. It has a swept volume of 2,195 cm^3. This engine develops 85 b.h.p. at 4,800 r.p.m., and its maximum torque is 115 lb-ft. A Solex, type 32 DIN X cross-country carburettor is fitted.

In the six-speed synchromesh gearbox, two of the speeds are for cross-country operation. Two-stage reduction gearing is employed in the axles. The first stage is by conventional bevel gears and the second is a spur gear pair at each hub. Both the front and the rear final drive units incorporate differential locks and are of the through-axle layout. The main suspension springs and the assister springs are of the coil type, and damping is effected by telescopic shock absorbers.

So far as the overall dimensions are concerned, the width is 6 ft 11¼ in and the length 15 ft 1 in. The angle of approach is 48 deg and the angle at the rear is 45 deg. Under the differential unit the ground clearance is 15·7 in and under the axle it is 18·5 in. At the centre of the vehicle the height of the top of the frame is 32·8 in in the laden condition and 34·08 in in the unladen condition. The maximum permissible load on the front axle is 4,070 lb and that on the rear is 5,500 lb. A drop side body, the interior dimensions of which are 106 in long × 78·7 in wide × 19·6 in high, is employed. Disc type wheels with 9 × 20 rims, and 10·00-20 tyres with cross-country treads are fitted. The



Two views of the Kässbohrer, 32 tonne trailer, showing how all eight wheels on each bogie are steered by a linkage connected to the drawbar assembly. A crossed cable interconnects the front and rear steering linkages

speed of the power take-off shafts at the front and rear is 540 r.p.m. at 2,350 engine r.p.m. At these take-off points the effective power output is 30 b.h.p.

Kässbohrer

Among the many trailers that Kässbohrer manufacture is a low-platform unit with an all-up weight restricted by German law to 32 tonnes. In fact, the vehicle has been designed to carry 45 tonnes for operation in other countries. There is one eight-wheel bogie at each end of the vehicle, and either of them can be withdrawn to facilitate loading the platform. The wheels are carried in the following manner. On top of each bogie is a transverse tubular member on each end of which is pivoted a rocker arm. Carried under the ends of the rocker arms are four, ball-bearing turntables. Under each turntable is a semi-elliptic spring on which is mounted a short axle, which in turn carries two wheels, one on each side of the spring. All the spring shackles are universally mounted to give complete freedom for the wheels to deflect naturally to follow the contours as they travel over rough ground. These shackles pivot about pins through the spring eyes in the normal manner, but at their upper ends they pivot about a horizontal axis normal to that of the spring eyes. A three-position valve is provided so that the pneumatic brakes can be adjusted to suit the unladen, semi- and fully-laden positions.

As can be seen from the accompanying illustrations, all the wheels are steered by a linkage system connected to the drawbar. Two rods, one on each side, are connected between the assemblies carrying the front two pairs of wheels and the drawbar, and two more rods above the turntables interconnect those carrying the front and rear pairs on each side. The front and rear drawbar pivot assemblies are interconnected by a crossed cable so that both bogies are steered. The drawbar can be fitted either at the front or at the rear. It is spring-loaded so that it normally remains in the horizontal position when not connected to the vehicle. This greatly facilitates coupling the tractor to the trailer. As can be seen in the accompanying illustration, a cross bar that carries the rear lamps is fitted in place of the drawbar at the rear.

The vehicle can be towed with the platform in any one of three positions. For normal operation the mid-position is employed, but the load can be lowered for passing under low bridges or it can be elevated to traverse rough ground. The actual heights of the platform in these three positions, as well as its overall dimensions, are normally specified by individual customers. Elevating and lowering the platform is effected by an electro-hydraulic system. Batteries to

The Kohlenkuli vehicle manufactured by Robert Schenk carries two conveyor belts for unloading

On this mobile test trailer, manufactured by Peter Bauer, the housing for the dynamometer can be seen on the left and the control cabin, the interior of which is illustrated below, is on the right

serve the system are carried on the trailer and they are charged in the normal manner from the generator on the tractor. The hydraulic pump is flanged directly on to the motor.

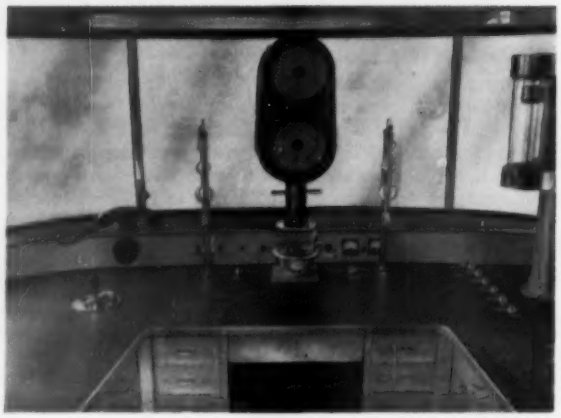
Kässbohrer also make pneumatic tipper trailers. Pneumatic tipping gear is used extensively in Germany. It would appear that provided there is space available for the accommodation of the large diameter jack needed, and also provided the tractor is in any case equipped with a compressor for brakes or other services, the pneumatic installation is less expensive than hydraulic gear. One of Kässbohrer's most recently developed vehicles is designed for a total load of 18·2 tonnes, although it is restricted by legal requirements to a lower figure. Tipping is effected by two pneumatic jacks, and compressed air is supplied from the brake system. Each jack cylinder has an internal diameter of 50 cm.

The body can only be tipped sideways, but it can be tipped with or without the tractor connected. If the tractor is not connected, the compressed air supply is taken from four air bottles, mounted on the chassis and from the tubular longitudinal frame members of the tipper body, which also are compressed air containers. The air pressure for operation is normally 5-6 kg/cm^2 but the system can be operated at pressures as low as 3 kg/cm^2, even when the body is in the fully laden condition. A useful feature is that the rams automatically extend and retract a short distance several times at the end of the extension stroke, so as to shake the load free.

Miscellaneous special vehicles

Mechanical handling equipment is being adopted increasingly, even among the smallest businesses. This trend is exemplified by the demand for special vehicles for the delivery of coal. One such vehicle is the Kohlenkuli, manufactured by Robert Schenk, of Stuttgart. The cab-over-engine layout has been adopted and a hopper type body has been fitted. This body is divided into four compartments and can be loaded by mechanical means, either to its maximum capacity or with different weights of coal in each of the four compartments.

The hoppers discharge on to a conveyor belt mounted on the chassis frame immediately beneath them. Each hopper discharge nozzle is closed by a horizontally sliding plate which can be withdrawn by hand. A second conveyor belt is stowed alongside the body. It can be lifted by a hydraulically-operated hoist on the rear of the vehicle and



placed in such a position that the conveyor belt under the hoppers discharges the coal on to it; then the coal is transported by the second conveyor belt to its final delivery point, for example, a manhole in a pavement or a chute in the side of a building. Both conveyor belts are hydraulically driven and the hydraulic jack in the hoist can be used to elevate or lower the second conveyor belt, according to the height at which it is required to discharge.

A surprising feature of this vehicle is that the hopper and the two conveyors are painted cream. This has been done at the customer's request; the reason is that the carmen using a clean vehicle of a light colour tend to take a greater pride in their own personal appearance and smartness. This is a good thing, since it enhances the prestige of their firm.

Peter Bauer, of Cologne, manufacture a number of special trailers. One of these is a vehicle test trailer made to the specification of the B.U. Aral concern, of Bochum, who supply petroleum products. This trailer is intended for touring the country as part of a free service for customers of the petroleum company.

When the trailer is in action, the ramps shown in the accompanying illustration are lowered, and any vehicles up to 1½ tonnes weight can be taken up the ramps until the driven wheels are resting between the rollers mounted on the trailer chassis. These rollers are connected to a dynamometer at one end of the trailer, so that the power

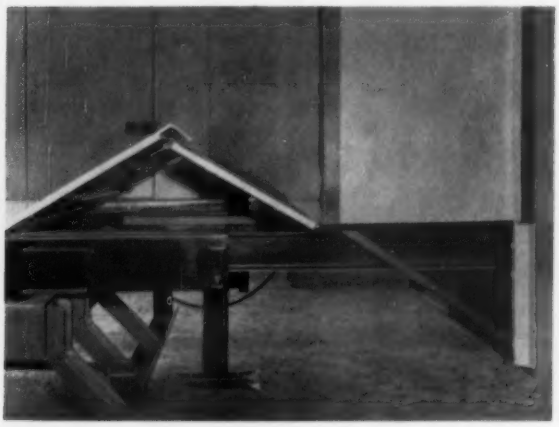
output of the vehicle can be measured under varying conditions. A cab is mounted on the other end of the trailer and it contains, in addition to the bench, dials and fuel measurement gauges, drawers that are specially designed to carry the full range of jets likely to be needed for different carburettors, as well as tools for making adjustments. With this trailer, tuning can be carried out scientifically.

Another vehicle by the same manufacturers is the stainless steel tank trailer shown in an accompanying illustration. It is designed to transport beer in the most economical manner possible. It is of interest to trace the lines along which the transport development, culminating in the use of this vehicle, proceeded. Originally, the beer was transported in half-litre bottles. To carry 110 hl of beer in this manner, three trucks and two trailers were necessary. Later, the same quantity was carried in 150 barrels, in 1½ trucks and one trailer. Further economy was effected by carrying the beer in large pressure vessels by which means the transport required for 110 hl was reduced to one truck and one trailer. Finally, the new tanker trailer, which by itself is adequate to carry 110 hl of beer, was designed.

This tanker trailer by Peter Bauer is designed to discharge its load of beer directly into the bottling machine

To maintain a reasonably constant temperature, the tank is lagged with 150 mm of insulation material. It is filled almost to the top so that baffling to prevent surge is reduced to a minimum. To save handling costs, the tank is emptied by forcing carbon dioxide or sterilized air into it, and the beer is discharged directly into the machine for filling the bottles.

Deplirex, extending-sided vehicles are made under licence in Britain by E. W. Campion and Sons Ltd., of Leicester. In Germany, Karosseriefabrik N. Trutz, of Coburg, make these vehicles. The extending bodies can be fitted to any size of vehicle. That shown in the accompanying illustration is on the Tempo Matador 1400 chassis. This type of body is suitable for a wide variety of applications and in many respects has considerable advantages over a conventional caravan. This is because there is no legal restriction on its maximum width, provided that, when folded, the vehicle satisfies the legal requirements for road vehicles. The overall dimensions of the extendable portion of the body illustrated are 12 ft 6 in wide and 11 ft 6 in long. Larger vehicles have been constructed and fitted out for use as mobile displays and photographic workshops, as well as for many other purposes. The sides can be designed to extend hydraulically or manually, and the stability of the vehicle in the extended state can be ensured by fitting additional supports under the frame of the extension and under the chassis of the vehicle.



The illustration above is of a typical cross section of a Deplirex extending-sided vehicle, by Karosseriefabrik N. Trutz. Below is one of these bodies on the Tempo Matador 1400 chassis

MACHINE RIVETING

ON many components of small or medium size, a riveted assembly can offer significant advantages in weight, space occupied, cost, or production time in comparison with bolted or screwed assemblies. If machine riveting is employed it may well enhance appearance, since the work is neatly executed and needs no finishing operation. Machines for this purpose are manufactured in a range of sizes and capacities by Turner Machine Tools Ltd., Princip Street, Birmingham, 4. In general, the machines are grouped in two categories: rivet spinning machines and rotary vibrating riveting hammers.

Spinning Machines

The smaller capacity machines are optionally equipped either for pedal or air operation. Pedal operation is satisfactory for rivets up to $\frac{1}{4}$ in diameter but, as female labour is customarily employed, air operation is preferable as it enables the operator to be seated and reduces fatigue. The larger machines, for rivets up to $\frac{1}{2}$ in diameter, are available only with air equipment. Air operation is recommended for closing rivets, however small, in relatively delicate

(Above) Air-operated rivet spinning machine, for rivets up to $\frac{1}{4}$ in diameter

(Right) Rivet spinning machine with swinging and indexing fixture for planetary gear assemblies

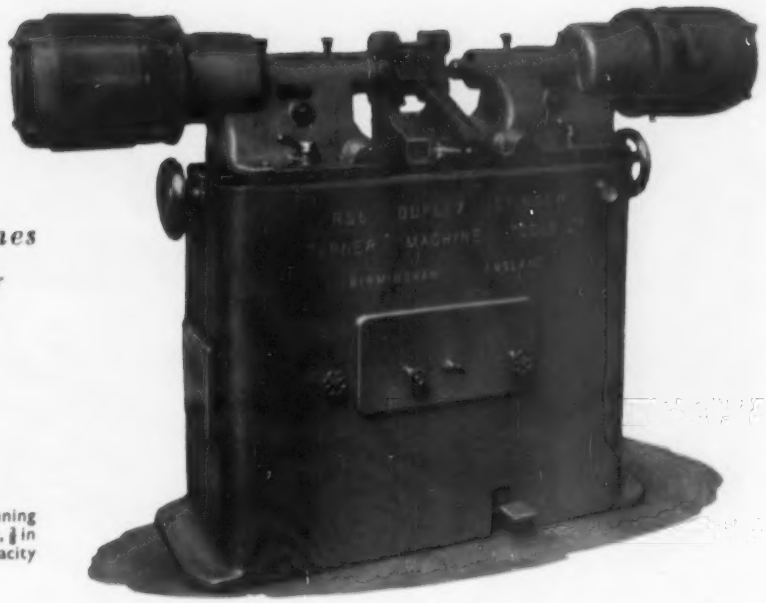
(Below) Rotary vibrating riveting hammer, $\frac{3}{8}$ in diameter rivet capacity

materials, such as fibre, plastics or ceramics, where it is essential to control the riveting pressure in order to avoid the risk of fracturing the component.

The spinning type of machine is generally used where it is necessary to form a head on the end of a rivet, stud, or pin without expanding the shank into the hole. They are, therefore, especially suitable for riveting links, toggles, swivels and pivoting parts where a freely-moving joint is required. For such items as hinges and other multi-part moving joints, duplex spinning machines may be used as both ends of a plain pivot pin are then riveted simultaneously. In practice, the stroke of the machine can be regulated to give any degree of initial tightness to suit the requirements of the work.

Spinning machines are not, however, restricted to "loose" riveting and can be used for securing parts firmly together. They will not, of course, make such a tight joint as can be

Turner Spinning and Rotary Vibrating Machines for Component Assembly



Duplex rivet spinning machine, air-operated, $\frac{3}{8}$ in diameter rivet capacity

obtained by use of the vibrating hammer type of machine. Particularly they are suitable for assemblies where a neat appearance is as essential as a correctly formed rivet head. Typical applications occur on such bodywork items as locks, latches, hinges, window-winding gear, and bonnet, boot, and hood lift mechanisms. They are widely used in the manufacture of electrical apparatus and equipment, characteristic instances being the attachment of contacts and fibre cam abutments to contact-breaker arms. On the chassis, spinning is employed on a number of the smaller components, such as steering linkage ball joints, control mechanisms, and engine auxiliaries.

Standard rivet spinning machines, if equipped with special tooling and operated with the driving motor switched off, can be used as "squeeze" riveting machines for closing relatively soft rivets, mostly of aluminium or copper. This method is quick and silent, and it expands the rivet as well as heading it. It obviates any tendency to mutilate very soft rivets, which sometimes occurs when spinning or hammering them. If required solely for squeeze riveting, machines can be supplied with a non-rotatable spindle and without electrical equipment.

All models are built for continuous heavy-duty operation. The spindle runs in generously dimensioned phosphor-bronze bearings and ball thrust races are fitted to sustain the pressure when the load is applied. The majority of the standard machines are driven by direct-coupled, flange-mounted motors but for larger diameter work and where slow rotational speeds are required for special applications, the drive is by vee belts from a motor adjustably bracketed to the rear of the machine column.

Air equipment comprises an air cylinder, a regulating valve with pressure gauge, pedal actuated control valve, stop valve, and the necessary internal piping. In addition to speeding the rate of production and reducing the physical effort required of the operator, it is indispensable for riveting operations in glass, ceramics, plastics, in metal-to-wood constructions, or in any delicate or fragile components where a controlled pressure is essential.

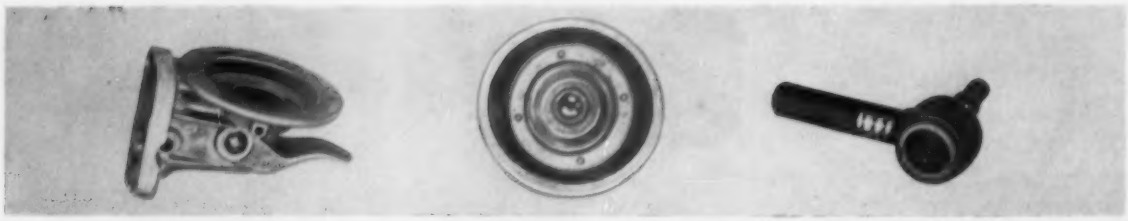
The range of spinning machines produced covers requirements for mild steel rivets in all sizes up to $\frac{1}{2}$ in diameter. All are floor-mounted, but the smallest size, which has a capacity up to $\frac{1}{8}$ in diameter rivets, is alternatively available for bench mounting. On machines for rivets up to $\frac{1}{8}$ in diameter, for example, the maximum distance from worktable to spinning rolls is 16 in and the throat depth varies in different models from $5\frac{5}{8}$ in to 18 in. The driving motors range from $\frac{1}{2}$ h.p. for $\frac{1}{8}$ in diameter machines to 3 h.p. for the largest model handling up to $\frac{1}{2}$ in diameter rivets. Duplex horizontal spindle machines for $\frac{1}{16}$ in, $\frac{1}{8}$ in and $\frac{3}{8}$ in diameter rivets will accept work between the spinning rolls up to a maximum width of $3\frac{1}{4}$ in, 12 in and 8 in respectively.

In operation, the head is formed on the rivet by the pressure exerted by a rotating spinning tool. This usually consists of a pair of rolls carried in a roll-holder screwed to the machine spindle. Pressure is applied either manually by a pedal lever operating through toggle links or, alternatively, by an air cylinder controlled by a pedal type valve. Under the action of the rolls, the metal at the end of the rivet is spread to form a perfectly finished head virtually instantaneously and without expanding the rivet shank. The machines are silent in operation.

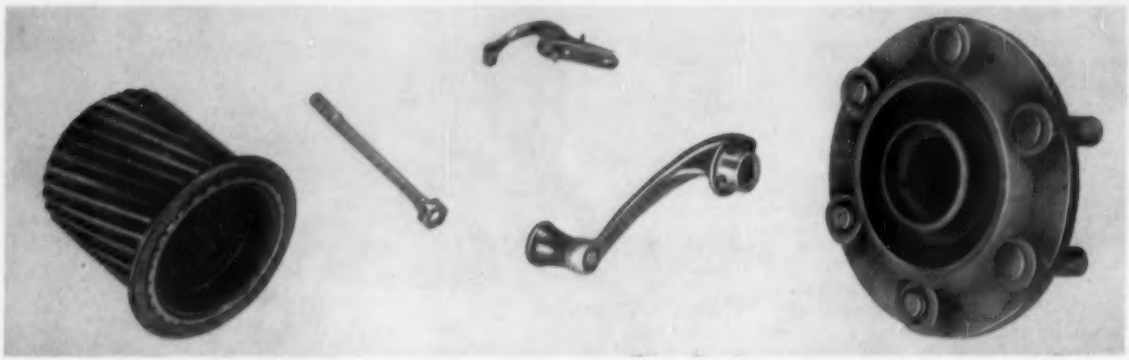
A full range of standardized rolls, classified by size, radius and depth of form, are manufactured to deal with any rivet within the capacity of a particular machine. It includes straight-profiled rolls for flush riveting into a countersunk hole and bevelled rolls for producing a shallow conical head. The company undertakes the design and manufacture of roll-holders, rolls, anvils and work-holding fixtures to meet the specific requirements of particular workpieces. Additionally, the machines can be used for spinning over bushes, rings, component retaining lips or certain types of hollow rivets, for which special tooling equipment is available.

Considerations of importance in spin riveting operations are:—

1. Length of rivet. Generally the length of rivet shank projecting from the component should not be more than the diameter of the shank. Frequently it may with advantage be somewhat less than the shank diameter.
2. Fit of the rivet in the component. Since to spin a head does not appreciably expand the shank diameter, the rivet should be a reasonably good fit in the hole.
3. Rivet support. If the rivet is not adequately supported by the component a support block may be necessary to



Typical riveted components assembled on spinning or rotary vibrating machines. Above: fuel pump operating lever, fuel pump diaphragm, steering linkage ball end. Below: synchronizer sleeve, high-tensile bolt, contact breaker arm, window wind crank, wheel hub



prevent any tendency for the rivet to bend when the roll pressure is applied.

4. Tool clearance. Sufficient space must be available to allow the roll holder to revolve freely without fouling the component. A spinning machine cannot be used for riveting very closely into an angle or near to a projecting rib or wall.

In connection with the fourth point it may be mentioned that the company make many special roll-holders for use on small and intricate components. It is not always possible, however, to produce a roll-holder that is sufficiently large to perform the necessary work on the rivet and at the same time is small enough to clear closely adjacent obstructions. In general practice a $\frac{1}{4}$ in diameter rivet, for example, cannot be closed by spinning if located nearer than $\frac{1}{2}$ in to $\frac{3}{4}$ in from any vertical face, although this difficulty may sometimes be overcome by the use of a solid spinning tool.

Rotary Vibrating Hammers

On these machines rivets are headed by a succession of rapid blows from a snap tool. A camshaft, belt-driven from a motor mounted on slide rails at the rear of the column, operates a rocker arm and the hammering action is transmitted to the riveting spindle through a hickory helve. The spindle reciprocates in a long phosphor-bronze bush which is formed as a worm wheel and serves to transmit rotary movement to the spindle. Rubber cushions arranged above and below the rocker arm bearing, and also under the helve, are provided to absorb the shock. Operation is controlled by means of a pedal-actuated, disc-type friction clutch.

Five hammer machines are manufactured, with capacities ranging from $\frac{1}{8}$ in to $\frac{3}{4}$ in diameter mild steel rivets and driven by motors of from $\frac{1}{2}$ h.p. to 3 h.p. The model for $\frac{1}{4}$ in diameter rivets is illustrated as typical of the range. It has a throat depth of 12 in, the maximum distance from table to snap is 10 in, and the standard spindle movement is $1\frac{1}{2}$ in. It is driven by a 2 h.p. motor and the floor space occupied is approximately 22 in × 43 in.

Vibrating hammers are mainly used for the solid riveting of parts that require to be joined very securely. The rivet end is spread to form a neat head and the shank is expanded to fill tightly the hole in the workpiece. Rivets may be headed either tight or loose, however, by appropriate setting of the machine and selection of suitable snap tools. If required to deliver a lighter blow than standard, the machine can be fitted with an alternative smaller-lift camshaft.

Applications for which the hammer-type machines are particularly suitable are:—

1. Where the rivet cannot be adequately supported to permit spinning.
2. Where the rivet is too close to a projection on the component to admit the spinning roll-holder.
3. For relatively rough work where rivets cannot be accurately located and the operation has necessarily to be performed "free-hand" or with improvised tooling.

As regards insufficient support, it is found that a succession of light blows will produce a sound head on a rivet that might be bent by the pressure of spin riveting. In the case of riveting close to an obstruction, however, even when a tight joint must be avoided the operation can be performed satisfactorily providing the machine is suitably set.

In many instances, riveting to meet the requirements of the component can be effected almost equally well on either spinning or hammer type machines. Under such circumstances the spinning machine may be selected, as it is silent in operation. Apart from the riveting tools, it needs but few spares and it can function effectively with rivets of any size up to its maximum capacity.

By comparison with the spinning machine, the vibrating hammer is relatively noisy in operation, has a greater number of wearing parts, and is more restricted as regards the size of rivet it can handle. A hammer machine having a $\frac{1}{8}$ in rivet capacity is not usually suitable for heading rivets of much less than $\frac{1}{16}$ in diameter unless the camshaft is changed. On the other hand, it is more versatile than a spinning machine for servicing or jobbing work, as it can be operated "free-hand" or with makeshift tools.

With rear engined coaches, the 1½ deck layout enables maximum seating and luggage-carrying capacity to be obtained; also, passengers like this arrangement because it gives them a good view of the countryside

GREYHOUND SCENICRUISER COACH

A New American Vehicle for Long-Distance Express Operation

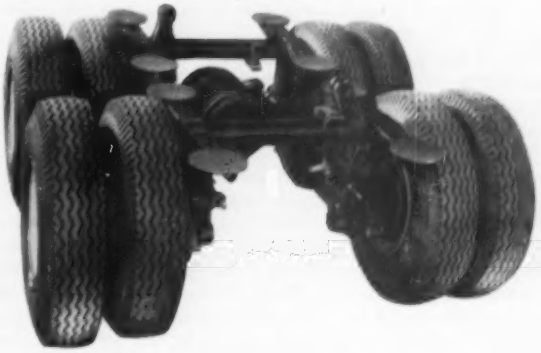
THE Greyhound Corporation of Chicago has recently placed in service a new 1½ deck, three-axle coach. This vehicle, known as the Scenicruiser, incorporates a number of unconventional features. It has been developed jointly by the Greyhound Corporation and the General Motors Corporation, Truck and Coach Division. The styling has been effected in consultation with the Raymond Loewy Associates. A wheelbase of 283⅜ in has been adopted and the overall length of the body is 40 ft. The height of the body is 10 ft 11½ in. Empty, the coach weighs 30,310 lb (13½ tons) and its laden weight is 40,000 lb (17·85 tons). In the laden condition, the front axle carries 4·85 tons, and there is 6½ tons on each of the rear axles.

Inside the vehicle there is accommodation for 43 seated passengers, 10 on the lower deck and 33 on the upper deck. To reduce the number of stops and thus to increase the average speeds over long journeys, a wash room has been provided. As can be seen from the accompanying illustration, it is at the foot of the three steps to the upper deck. In it, the lavatory is of the chemical type and the waste water from the washbasin is discharged through the engine exhaust system. The side windows are 6 ft long and, like the four sky-lights in the roof, are fitted with anti-glare glass. In addition to the provision of light luggage racks inside the coach, there is a luggage compartment of 375 ft³ under the upper deck. This is large enough to carry mail as well as passengers' luggage. The vehicle is of chassisless construction. Steel is employed for the body framing and corner posts, while the roof, side panels, bulkhead and floor are of aluminium. Even the decorative exterior panels carry a share of the load.

An air circulation of 2,000 ft³/min is dealt with by the ventilation system; of this, 500 ft³/min is fresh air. The air ducting is formed between the outer stressed skin and the trim panels. A separately controlled louvre, for the extraction of tobacco smoke and stale air, is fitted by each seat. Above the control is a notice requesting passengers to open it when smoking. Individual ventilators and reading lamps are also supplied. In summer, the incoming air is passed through a Tropic-Aire-Carrier cooling plant. It is said that, even in the extreme heat of the desert, this unit is capable of maintaining a temperature of 76-78 deg F in the coach. The compressor for this plant is driven at engine speed by the right-hand of the two engines that power the coach. To have employed a separate auxiliary motor to drive the compressor would not only have added to the complexity of the system and to the servicing attention required, but also a separate fuel tank would have been necessary and the fire risk would have been increased.

When the bus is stationary, the driver can operate a control to stop the left-hand engine and empty its hydraulic coupling. At the same time, the throttle of the right-hand engine is set automatically so that the unit runs at 600 r.p.m., and an overdrive gear with a ratio of 3·1:1 is engaged to run the compressor at 1,860 r.p.m. An automatic safety device is incorporated to stop the engine should the pressure in the Freon refrigerant become too high or too low. To prevent the bus from being driven away with the compressor in the over-speed gear, the control lever also locks the brakes of the vehicle in the "on" position. When the driver moves the

On the rear axle, there are eight pads to receive the bellows type pneumatic springs



The washroom, at the foot of the stairs to the upper deck, is incorporated to reduce the number of stops needed on long journeys and therefore to increase the average speed

control lever into the "on road" position, the brakes are released, the compressor is placed in direct drive and the left-hand engine is restarted automatically by coupling it with the right-hand one.

The two engines, each complete with its own cooling system, are mounted side-by-side under the floor of the upper deck behind the rear axles. In the event of failure of one engine, the other can be used to propel the vehicle. Both are four-cylinder, two-cycle oil engines of the well known General Motors design. Each develops 150 b.p.h. at 2,300 r.p.m. At this engine speed, the vehicle is travelling at 60 m.p.h. when direct drive is engaged.

To keep the height of the body floor to a minimum, and also to give ready access for servicing, the two engines are mounted so that together, they form an obtuse angled V, with their crankshafts parallel to the longitudinal axis of the vehicle. They drive through separate hydraulic couplings and a common gear train to a single gearbox. The hydraulic couplings compensate for slight differences between the speeds of the engines. A three-speed synchromesh gearbox of the constant mesh type is employed in conjunction with a two-speed auxiliary train to give six forward speeds. The two-speed train is controlled by a switch on top of the gear shift lever. With this switch either direct drive or an overdrive ratio of 0·768:1 is obtained without depressing the change-speed pedal.

A 200 amp alternating-current dynamo is belt-driven from the gear train that couples the two engines. Thus it operates regardless as to whether one or both engines are running. The current is converted to D.C. by a 24 volt rectifier, which is mounted within the engine air intake duct, so that it is adequately cooled. Although electrically-actuated oil pressure and water temperature indicators and warning lights for each engine are mounted on the instrument panel, both engines are stopped automatically if either the oil pressure falls too low or the water temperature rises too high.

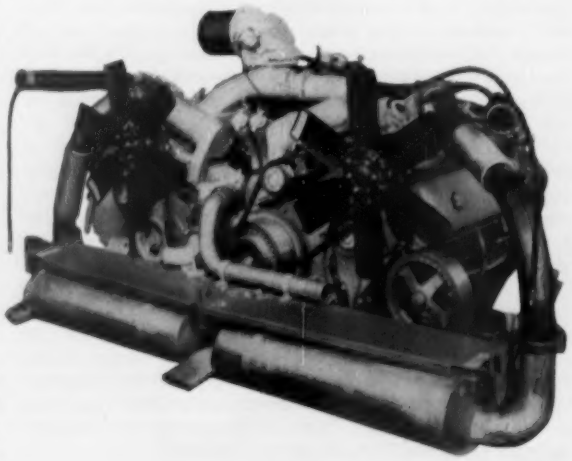
According to the Greyhound Corporation's analyses, no less than 87½ per cent of road failures of conventional vehicles are attributable to the power plant. However, the Scenicruiser not only has the safeguard of two independent engines, but the installation comprising the two engines, their radiators, exhaust systems and accessories can be quickly detached from the coach and wheeled away on a special bogie. All the fuel, air and electrical lines have quick-release couplings and, where necessary, are self-sealing to avoid any loss of liquid or air: this is a noteworthy time-saving feature.

When installed in the vehicle, the power plant is mounted on a frame, the front end of which is carried on two brackets secured to the lower corners of the engine bulkhead. At the rear, the frame is suspended on the lower ends of three vertical tubes, which have coarse-threaded union fittings at their upper ends for quick attachment to brackets under the body floor. All the mounting points are designed so that they have no loose parts that might be mislaid. It is claimed that with this arrangement, removal of the power plant and replacing it with another can be effected in a matter of minutes This is an important feature for operation in the United States, where labour costs are high, but fuel relatively cheap. Undoubtedly, off-the-road time with this vehicle will be reduced to a minimum.

One of the most interesting features of the vehicle is its suspension system. Pneumatic springs are employed. At each end of the beam type front axle is a yoke. These yokes are on top of the axle and are at 90 deg to it. On their ends are circular platforms, on which the nylon-reinforced rubber bellows, which form the spring units, are mounted. Thus, there are four bellows supporting the front axle. Above the two bellows on each side is a longitudinal beam which is secured to the body structure. This beam not only forms the support for the springs, but also acts as a balance duct to equalise the pressures in them. A telescopic, hydraulic shock absorber is fitted between the beam and the axle on each side of the vehicle.

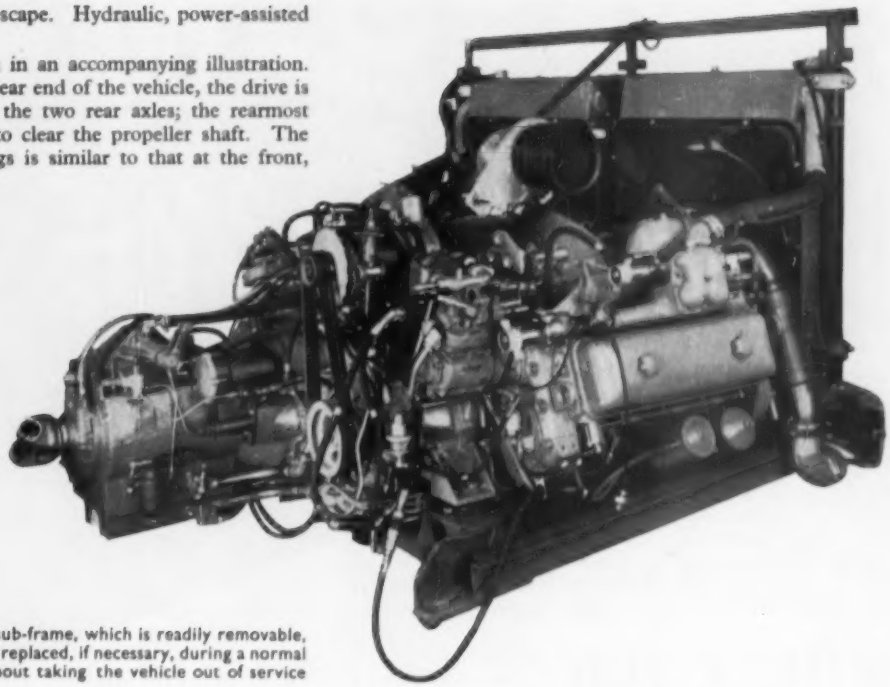
Fore and aft location of the axle is effected by trailing links. These links are pivoted on the vehicle structure forward of the axle. The rear end of the lower link on each side is secured to a bracket below the axle, and the rear end of the upper link is pinned to a bracket on top of the central portion of the right-hand yoke. Transverse location is effected by a Panhard rod, one end of which is connected to a bracket under the left-hand longitudinal member above the springs and the other end to another bracket on the right-hand yoke. An automatic height-corrector valve is mounted on the body structure over the centre of the beam axle. A link is fitted between the axle and the actuating lever of the valve. When the body sinks too low relative to the axle, the valve opens to allow compressed air to be pumped into the longitudinal members and thus into the springs to raise it again. On the other hand, if the level becomes too high, the valve moves in the other direction to allow some of

Two General Motors, two-stroke diesel engines are installed together in the form of an obtuse-angle V at the rear of the coach



the air in the springs to escape. Hydraulic, power-assisted steering is employed.

The rear axle is shown in an accompanying illustration. From the engines, at the rear end of the vehicle, the drive is taken to the foremost of the two rear axles; the rearmost axle is cranked upwards to clear the propeller shaft. The arrangement of the springs is similar to that at the front,



The engines are carried on a sub-frame, which is readily removable, so that the installation can be replaced, if necessary, during a normal schedule stop at a depot, without taking the vehicle out of service

but the yokes are fitted to cross tubes relatively high above the wheel axes. Long balance-duct members, one on each side, are fitted over the springs; each carries four springs, that is, two for each axle. The trailing axle is located in a manner similar to that employed for the axle at the front of the vehicle, but the rear ends of the links that afford fore and aft location are pivoted to the vehicle structure behind the axle. The forward ends of this lower pair of links are attached, one below each stub axle carrier forging, and the upper link is pinned to a lug on top of the rear cross tube. Each of these attachment points on the trailing axle also carries the rear end of another rod, the front end of which is attached to a similar position on the driving axle. Lateral location is provided by two Panhard rods, one for each axle. That on the trailing axle is connected to a bracket on top of the left-hand yoke, while that on the driving axle is connected in a similar manner to the right-hand yoke. The other ends of the Panhard rods are attached, one to each longitudinal member above the springs. All the pivots of the axle locating rods are rubber bushed. As at the front, telescopic, hydraulic shock absorbers are interposed on each side between the longitudinal members above the springs and the axles.

Two automatic height-corrector valves, one on each side, serve this rear end assembly. Their actuating levers are connected to the forward ends of the two yokes on the driving axle. Since two valves are employed, they can be applied to reduce the roll when the vehicle is cornering, as well as to correct the static height of the vehicle. Another feature that helps to reduce the roll when cornering is the relatively high position of the springs above the rear axle. These anti-roll precautions are necessary because most of the passengers are carried in the upper deck.

The desirability of automatic correction for height is widely recognised. In practice, there is only a limited amount of space available to accommodate deflection of the suspension above and below the static position, and the natural frequency of the system is dependent on the magnitude of the deflection to the static condition. If soft springing is employed, the static height of the system may vary appreciably, as between the fully and partly laden conditions; this restricts seriously the amount of travel available either above or below the static position. Moreover, the natural frequency in the unladen or lightly laden conditions generally is too high for comfort. However, if automatic height-correction is applied, not only is the static deflection, and therefore the natural frequency, constant regardless of load, but also the whole of the space available for deflection between the bump and rebound positions is used to the best possible advantage for riding over rough roads.

Apart from the facility with which height correction and anti-roll characteristics can be incorporated, there are, of course, other advantages to pneumatic springs. The spring units are light, compact and inexpensive. They are practically frictionless in operation, so damping is readily controlled; moreover, it is a simple matter to arrange for a damping valve to be incorporated, if desirable, in each air spring. A most important feature of air springing is that when the wheel is suddenly deflected upwards, an increasing rate is obtained. This helps to prevent resonance, and for other reasons is a desirable characteristic.

Ultrasonic Flaw Detection

AN ultrasonic flaw detector for non-destructive testing is available from Solus-Schall Limited, 15-18 Clipstone Street, Great Portland Street, London, W.1. It will detect discontinuities such as cracks, cavities, inclusions and unbonded joints between two surfaces. The apparatus is suitable for both single and double-probe scanning. As ultrasonic testing is suitable for light alloys and other non-ferrous metals, as well as for steel, the apparatus has a calibration control which allows direct calibration for metals other than steel. Forged and extruded materials are usually more suitable than cast materials for this type of testing, and as a general rule cast iron is not suitable for ultrasonic inspection.

Continuous production line for cold roll forming

THE COLD ROLL FORMING PROCESS

A Rapid and Accurate Method for Producing a Wide Variety of Shapes

A HIGHLY successful industrial production method, called the "cold-roll-forming" process, has been developed by the American The Yoder Company. It is a process whereby a flat strip of metal is passed through a series of rolls arranged in tandem to be progressively formed into an ultimate desired shape. Ordinarily, the metal does not require heat treatment before, during or after forming. The number of rolls required is determined by the character and intricacy of the shape, and by the thickness and kind of material to be formed. Therefore it is customary where a number of different shapes are to be made on the same machine, to use one having a base long enough to accommodate the maximum number of rolls ever likely to be required for any shape likely to be made on that machine.

The attractive appearance of roll formed sections has resulted in their general adoption for decorative trim and facings for cars, passenger coaches and buses, and for many other uses. The strength, lightness and uniformity of these sections, their adaptability to assembly by modern welding methods, their fine finish, low cost and other advantages, have also found use in the vast field of basic structural parts.

Owing to the necessity for great accuracy and uniformity in most roll formed shapes, the machines as well as the tooling must be designed to very close tolerances. They must also be quite sturdy so as to withstand, for a period of many years, the bending stresses, wear and tear incident to continuous operation at a high rate of speed.

A typical roll forming machine consists of a welded steel base on which are mounted two, three or more identical roll stands, each designed for holding one pair of rolls. For forming light, narrow shapes, the so-called outboard type machine is used. In this the roll spindles are supported only at one end, affording better visibility and access to the machine in changing and adjusting the tooling. However, the pressures required in forming most commercial shapes are such that they impose on the spindles bending stresses which can best be withstood by supporting them at both ends in adjustable anti-friction bearings. This construction also keeps the spindles in accurate alignment. This is known as an inboard type machine. The inboard type of machine can be quickly converted to an outboard type, simply by pushing the outboard housings in against the rear housings.

The inboard type, being the machine most extensively used, has been standardized in four basic sizes, for forming stock from 0·010 in up to 0·156 in thick and widths up to 16 in. Simply by providing a wider base, these machines can also be used for widths up to 30 in or more, although the capacity ratings in respect to stock thickness are thereby reduced owing to increased liability to deflection of the spindles.

Each of the four basic sizes can be made as long or as short as desired, with anywhere from two or three up to twenty roll stands, although more than 12 to 14 roll passes are seldom required. Thus an infinite number of machine sizes and lengths can be assembled from standardized components, at the lowest possible cost, to meet a wide variety of requirements most economically.

In both the inboard and outboard types, the drive housing at the rear of each roll stand entirely encloses all driving gears in an oiltight case. The gearing consists of a hardened steel worm and a high strength bronze worm gear mounted on the fixed lower roll spindle. As the upper roll spindle has to be adjustable to different levels to accommodate rolls of different diameters, it is driven through a toggle gear arrange-

ment which permits making these adjustments without sacrifice of the full pitch-line mesh of the drive gears. For applications in which these limits have to be exceeded, the gear housings are set back and the spindle driven through jack-shafts and universal couplings. This type has been made with spindles up to 15 in diameter, for cold forming structurals up to $\frac{1}{2}$ in thick and pipe up to 20 in diam, from plate up to $\frac{3}{4}$ in thick by about 94 in wide. These machines are used mostly in connection with electric-weld pipe and tube mills.

To facilitate quick and accurate alignment of the upper spindles, adjusting screws at both ends should be equipped with micrometer dials. These also provide the means of recording the final correct settings for each set of rolls, so as to save time thereafter whenever the same rolls are to be mounted on the machine for a new production run. The worm shafts of individual roll stands are interconnected by means of flexible couplings and are driven through V-belts from a motor mounted slightly to the rear of the entry end.

The outboard housing should be separately and completely removable from the ends of roll spindles—a few turns of hardened spinner type clamping nuts permits this removal, giving quick and complete access to ends of spindles for changes of tooling. The outboard housing may also be moved in on the spindles to reduce the span in forming heavy stock.

All parts of any roll stand of a given size and gear ratio are interchangeable not only with the corresponding parts in the other roll stands, in the same machine, but also in other machines of the same size, make, and gear ratio. As the wear and tear on the machine is ordinarily very small, the interchangeability of parts makes repairs and replacements easy, with a minimum of spare parts. Where several machines of the same basic size are in use, it is desirable to carry in stock one complete extra roll stand. This can in a few minutes replace any roll stand on the machine which may cause trouble.

When roll forming is not to be followed by other operations, such as trimming and forming the ends, welding, bending, etc., it is common practice to use cut lengths or blanks and even coiled stock which have already been given the finish ultimately desired. As the change of profile between roll passes is limited, the roll pressures, in cold forming light gauges of metal, are low enough to permit successful forming on a large scale of galvanized, electro-galvanized and electro-plated stock. Metals which have been subjected to mechanical and chemical surface treatments such as buffing, polishing, burnishing, etc., may also be cold roll formed successfully without objectionable marring of the surface. Hot dipped galvanized stock is being extensively used in cold roll forming, but is subject to greater limitations than are the other finishes.

First and most essential in tooling for cold roll forming are, of course, the main, or driven, rolls, with the spacers for holding them in proper lateral alignment on the spindles. Depending on the character of the shape to be formed, there may also be a pair of entry rolls or a guide to keep the stock, as it is fed into the machine, in proper alignment with the first pair of forming rolls; also idler rolls, bar guides, or shoes for pinching in of the edges and also to prevent vertical or horizontal deflection of the stock in its passage between successive roll stands. The idler rolls may also be designed to exert pressure from the sides, as an aid in forming the vertical surfaces of deep sections, such as channels and box shapes. Finally, at the exit end, a straightening guide, to prevent curving and twisting of the shape as it leaves the machine.

Small rolls or dies may also be provided for curving, coiling or ring forming. Dies for cutting to length, perforating and notching the ends may also be incorporated. They are mounted in an automatic flying cut-off machine installed in line with the forming machine. There may also be rolls for making lock-seam tubing; cutters for trimming stock to the exact width required; embossing rolls; in fact, a number of attachments with tooling may be provided for performing operations other than strictly roll forming, with little or no increase in labour cost or reduction in speed.

In designing the main rolls, the open side of the section to be formed is generally made to face up; that is, the edges of the strip are bent upwards rather than downwards. When the profile is to have openings facing both up and down, the larger or most central opening is usually made to face up.

As to the number of roll passes required, there are, of course, definite limitations to the amount of forming that can be done in any single roll pass, and these limitations must be kept in mind. In respect to sequence, the forming must start at the centre or as near to it as the profile permits, proceeding in the successive roll passes towards the edges. The reason is that many bends or beads if first formed at or near the edges, would lock the metal in place between the rolls, causing it to tear if subsequent forming is to be done nearer to the middle. Such forming obviously cannot be done without pulling the stock from both edges in towards the middle. Therefore, once the metal is locked between the rolls by the forming of angles or beads near the outside edges any subsequent attempt at bending nearer the centre will necessarily result either in stretching or tearing the metal.

If, however, the forming near the edges is of such a character that it does not prevent the stock, confined in the roll passes, from being pulled in toward the centre in subsequent passes, exceptions may be made to this rule.

As to limitations to the amount of forming that can be done in any roll pass, a basic rule is that under no circumstances should a bend be great enough to "carry back" through the strip into and beyond the preceding roll pass. To understand what is meant by this, and by the words "carry back," bear in mind that the flat strip is progressively being made a little narrower by being bent in towards the vertical pass line. For example, in forming a channel, say one inch wide, the shape tapers from the full strip width at the entry end which may be, say, three inches wide, to a final width of only one inch at the exit end.

Because the metal is bent to a sharper angle in the third pass, and the edge held tightly along the tapering edge line, a line of stress will be set up diagonally between the bend line in the third pass and the edge of the strip near the second roll pass. In the shallow channel, this stress line intersects the edge of the strip near the second pass, but still not in, or extending back beyond, this pass.

In the deeper channel, having wider flanges, but otherwise of the same thickness and ultimate width, the stress line would be about the same, but with the big difference that in this case the diagonal stress from the third roll pass backwards to the edge would extend to a point somewhere back of the second roll pass. This would cause an excessive stress at the outer edges of the strip as it comes out of the second roll pass, causing the edges to be stretched in passing through. The greater length of the metal here would cause the finished shape to have wrinkled or wavy edges.

To prevent this from happening, the channel with the wider flanges would have to be formed less abruptly; that is, in more roll passes than one with narrower flanges. When using heavier gauges—say, 0·090 in and heavier—the carry-back to the diagonal stress line will be even longer than just indicated, hence the amount of forming between the roll passes must be still further reduced in order to prevent stretching of the edges. This increases the number of roll passes required.

In other words, the angle or length of the "carry-back" depends on thickness as well as width of leg to be formed,

and also on the kind of stock used. All three factors must be considered in their relation to the spacing between the roll stands. As no exact mathematical formula exists for working out the answers, the roll designer must lean heavily on past experience in comparable cases. Where the section is fairly complex it is also important that the roll designer be free from bias and pressure from the outside sources.

More severe bends can normally be made in the initial stages than in the final stages, for the final passes must bring the shape to its exact and final profile and insure against "spring-back." In fact, with springy stock, slight over-forming may be necessary. All passes must be so designed that roll surfaces are in contact with the largest possible area of the stock being formed, and so balanced between the left and right sides of the centre line as to ensure good traction and freedom from side pull.

Theoretically, the pitch diameters of the rolls are the same for all the passes, but as the strip elongates slightly and to a varying degree in passing through the rolls, the pitch diameters are progressively stepped up to a slight extent so as to maintain a satisfactory and uniform tension on the strip for traction purposes. This may be very important because if the traction should decrease between any two passes, the one pass would be pushing the strip forward faster than the next pass would be pulling it in, often resulting in buckling of the stock and interruptions of the operation for cutting off and removing the buckled strip.

To aid in pulling in the edges of the strip in entering successive roll passes, and especially in the initial two or more passes, where most of the forming is being done, flanges must be provided on the female rolls. The dimensions and profiles of these flanges should be sufficient to prevent scoring of the outside surfaces of the stock as it is being forced in and downward in the lower or female rolls.

Owing to interference from idler rolls and for other reasons, it is not always possible to use flanges of the desired depth. When this is the case, it is necessary to give the inside edges of the flanges a very generous radius, regardless of the size of the flanges.

For the longer roll life desirable in large scale production, hardened tool steel is usually most satisfactory and economical. It should have good machining quality, must harden to 60-30 Rockwell C., with a minimum of warping, and be capable of being ground and polished to a smooth surface. Using tool steel rolls on aluminium or brass stock, from four to five million feet are frequently obtained before regrinding is necessary. For some parts of the profile an especially tough grade of metal may be chosen, while for others, materials may be chosen for hardness or wear, or both. The split roll design also makes it possible to replace worn sections separately.

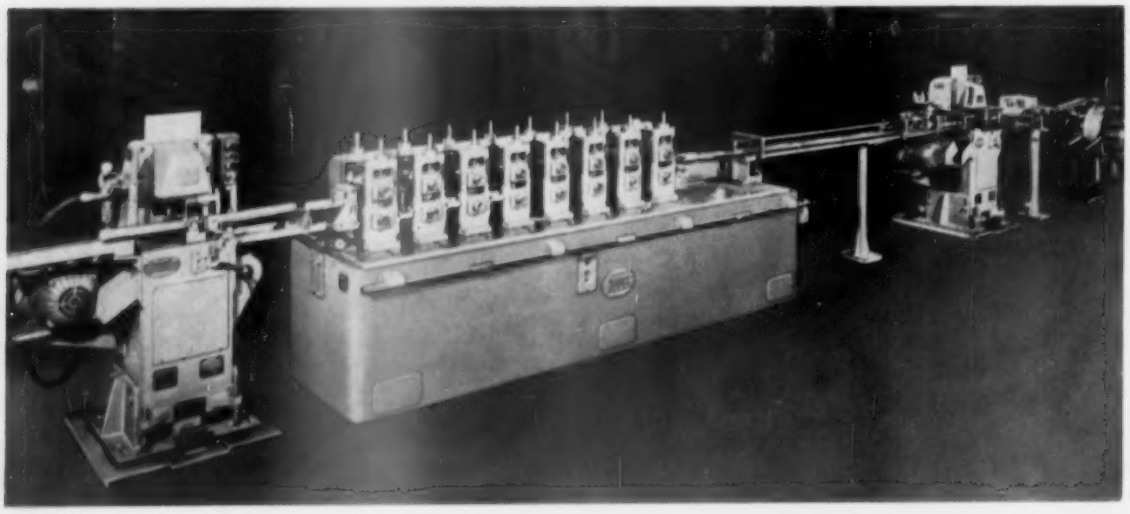
Split rolls are especially desirable for forming wide sheets in which flat areas predominate, such as V-crimp and similar roof sheets and siding; the flat parts of the rolls which do no forming may then be of soft steel, while hardened tool steel is used for those parts which do the forming. In certain cases it is advantageous to chrome plate the rolls. This is generally done to minimize scratches and pressure marks on soft or pre-coated stock. However, high carbon high chrome is recommended rather than chrome plating to avoid the necessity for re-plating every time the rolls require regrinding. When hard-surface stock is used, or when the stock has an affinity for the rolls which may result in damage to the finish, bronze rolls are sometimes used to minimize the "pick-up."

For forming unpickled, scaly material, an extremely hard metal is required, while for cold rolled steel, aluminium, or its alloys, a high grade oil hardening steel, is satisfactory. For stainless, a straight high carbon steel is recommended, possibly with some of the rolls made from a bronze alloy.

In order to prevent the guides from picking up surface particles, it is often advisable, especially in forming very soft metals, also to have the hardened and polished guides chrome plated. Similar considerations govern the choice of materials for straightener, idler rolls, etc. Wear and replacements of rolls and dies are the principal items of expense. In the majority of applications, three or four million feet can be produced before regrinding is necessary, and several regrindings can be made before ultimate replacement. Keeping the rolls clean greatly prolongs their life.

Standard roll forming machines are usually equipped for a constant speed of 100 ft/min, but may be designed for a higher or lower speed to meet special requirements. Allowing for avoidable and unavoidable delays during working hours, the daily production at this speed will average about 30,000 lineal feet. This may, but seldom is, stepped up by end-to-end welding of successive coils to avoid the slight loss of time incident to the starting of each new coil through the machine. For most applications, the daily production even without continuous feeding, is so great as to exceed requirements. In fact, many machines are operated only a few days per month, yet are highly profitable.

Typical roll forming operation on coiled strip



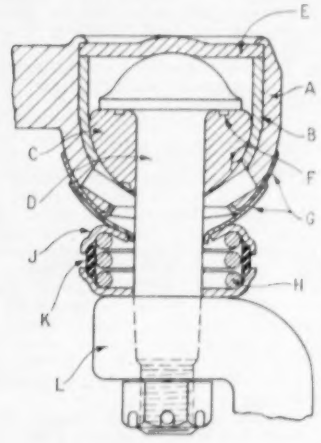
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Shimmy-damping ball joint

WITH reference to independent front wheel suspension systems of the type in which the steering knuckle is connected to upper and lower control arms by ball joints, an earlier patent, No. 652432, stressed the desirability of one of the ball joints being of the controlled-friction type to damp out resonant vibrations likely to cause wheel shimmy. The subject of this invention is an upper ball joint for this specific purpose.

In the housing *A* attached to the upper control arm is fitted a cup-shaped wearing sleeve *B* in which bears a hemispherical



No. 727622

friction member *C*. Through this extends the pivot stud *D*, the flat under surface of its head seating on member *C* and the hemispherical upper surface engaging a depression in the closure plate *E*. Grooves *F* direct lubricant to the bearing surfaces.

The slot in the base of the housing is closed by cupped sealing washers *G* and below these is a stout helical spring *H* enclosed in covers *J* and sealed by rubber ring *K*.

When the stud is semi-permanently secured to the steering knuckle *L* the spring *H* is compressed, imposing constraint on the sealing washers *G* and also on the stud *D* which results in loading member *C* to resist either rotational or tilting movement. Spring strength will be selected to provide the minimum loading necessary to meet the requirements of different vehicles. *Patent No.* 727622. *Thompson Products Inc.* (*U.S.A.*).

Hard-metal faced bearing assemblies

A PERFORMANCE superior to that provided by the use of hardened steel or chromium plated journals in bearings of a non-ferrous base material is obtained by forming one of the rubbing surfaces of a hard metallic carbide material, particularly tungsten carbide.

The specification is very widely based and includes other metallic carbides in combination with silver, bronze, lead-base, tin-base, or aluminium bearing surfaces.

In general the thickness of the carbide coating should be within the range of from 0·001 in to 0·010 in and a thickness of 0·004 in to 0·007 in is preferred. In some instances a shaft member of solid cemented carbide may be used with equally satisfactory results.

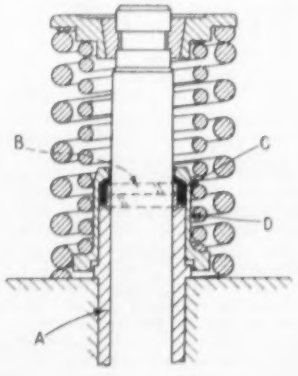
Non-ferrous bearing materials may be from 0·005 in to 0·100 in thick and if an overlay coating is employed, such coating should have a thickness in the range of 0·0005 in. to 0·003 in.

In the specification are tabulated the results of embeddability tests on a wide variety of steels and on tungsten carbide in silver, copper-lead-tin, lead-base babbit, sintered copper base material, and aluminium alloy bearing metals. The invention is claimed to be of specific application to automobile and aircraft internal combustion engines, as well as for other machine purposes. *Patent No.* 727226. *General Motors Corporation* (*U.S.A.*).

Sealing valve guides

METHODS of sealing valve guides against the leakage of oil from the valve chamber to the port, or the escape of gas in the opposite direction, by means of a rubber ring clamped by a gland nut, are already known. In view of the high working temperatures at that point, such rings will not permanently withstand stresses arising from heat and sliding friction and the sealing action becomes progressively poorer.

To overcome this weakness, two split metallic rings are fitted in addition to a rubber ring which enshrouds the metal rings and overlaps to engage the valve stem. This assembly is constrained by a



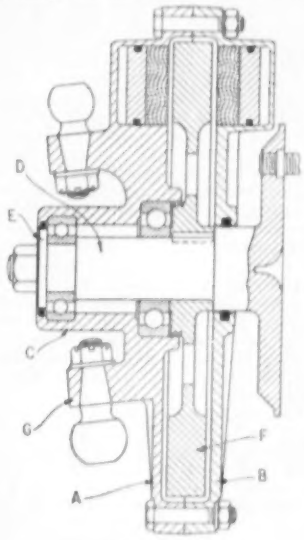
No. 727385

flanged sleeve on which the secondary valve spring is seated.

The drawing shows a valve guide *A* formed at its outer face with an internal conical recess in which is seated the lower of the two metallic rings *B*. These rings are compressed and sealed at their outer surfaces by a rubber ring *C*, which also contributes to the sealing action by bearing, at its upper face, directly on the valve stem. Sleeve *D* is loaded by the valve secondary spring to compress the assembly into sealing contact with the valve stem. It is an inherent advantage that this arrangement provides automatic adjustment of the sealing pressure. *Patent No.* 727385. *Daimler-Benz A.G.* (*Germany*).

Wheel and disc brake assembly

ON the majority of present-day vehicles a front wheel rotates on bearings carried by a non-rotatable stub axle. When disc brakes are employed, such a construc-

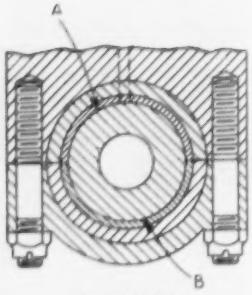


No. 727469

tion gives rise to a relatively complex wheel and brake assembly that is heavy, costly to produce and difficult to assemble or dismantle. It is proposed to simplify the construction by mounting the wheel on a stub axle rotatable in bearings carried by the fixed brake housing. The example illustrated is one of several designs described in the specification.

The brake assembly comprises a non-rotatable housing formed by two beams *A* and *B*, substantially rectangular in shape and vertical in disposition, which are rigidly connected together by a pair of bolts at each extremity. Beam *A* has an axially extending hub *C*, which accommodates two axially spaced bearings of different diameters in which is mounted the rotatable stub axle *D*. At its outer end the axle is shouldered and terminates in a circular flange to which the road wheel is attached. On the other end is fitted a thick washer *E* by means of which the axle is drawn up axially to locate the brake disc *F*, keyed or splined to the axle, against the larger diameter bearing.

Formed on beam *A* are upper and lower lugs *G* and in these are mounted in axial alignment, and at an appropriate inclination to the axle, spher[illegible] headed pivot pins. The brake asser[illegible] thus serves as the steering knuckle [illegible] the suspension linkage. Braking mechanism, comprising hydraulic cylinder and piston elements, may be fitted at either or both extremities of the housing. *Patent No.* 727469. *Dunlop Rubber Co. Ltd.*



No. 726799

Composite main and connecting rod bearings

THE use of relatively hard bearings, such as lead-bronze bearings, has the disadvantage that extremely accurate machining is necessary since they will not deform, as will white-metal, to conform to the crankshaft. Furthermore, any foreign matter that may pass into the bearing with the lubricating oil does not become embedded and is liable to score the shaft.

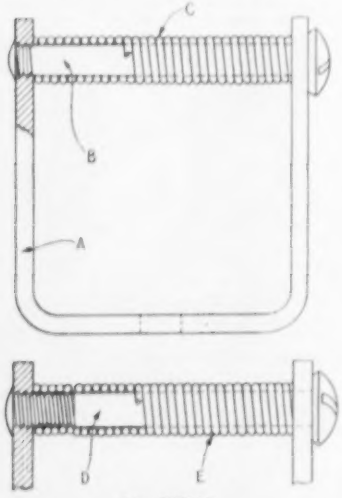
By forming a bearing of one half-shell lined with white-metal and the other with lead-bronze, it is claimed that these disadvantages can be mitigated. Foreign bodies will be embedded in the white-metal lining and, to some extent, the bearing can adapt itself to the shaft in the event of small inaccuracies in machining.

The white-metalled half-shell is disposed on the less heavily loaded side of the bearing axis. In the example of a main bearing of a conventional engine having the cylinders arranged vertically, lining *A* is of white metal and lining *B* is of lead-bronze. *Patent No.* 726799. *Daimler-Benz A.G. (Germany).*

Spring clip

THE invention proposes the use of a close-coiled helix of wire instead of the usual tube. By coiling the wire to a close fit on the bolt shank the end coils will not slip over each other and the locking pressure is withstood by the abutment of adjacent coils. No need arises to maintain a large stock of distance pieces of different sizes as any diameter or length of helix can be manufactured by machine at short notice from a stock of wire. The ends of the helix may be ground square and the bolt may be secured in the usual way by screwing into a hole tapped in one of the arms of the clip and riveting over the end.

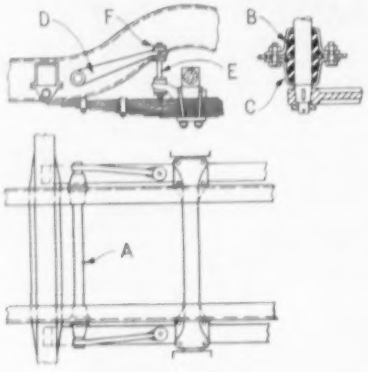
As an example, the drawing shows a clip *A* in which the bolt *B* is passed through a plain hole in one arm and screwed in a tapped hole in the other arm. A close-coiled wire helix *C* of uniform diameter and with ground ends is threaded over the bolt and drawn up solid to serve as a rigid distance piece. In a modification, the bolt *D* is screw-threaded for a greater length and the helix *E* has a number of turns of a diameter and pitch to fit the exposed threads. *Patent No.* 727115. *Toledo Woodhead Springs Ltd.*



No. 727115

Stabilizing passenger vehicles

TORSION rod stabilizers are applied to both front and rear axles of large, long-wheelbase passenger vehicles having rigid axles and conventional leaf-spring suspension. Such stabilizers, or anti-roll bars, are mainly used on the independently sprung wheels of automobiles, in which the roll axis is relatively low. In vehicles having rigid axles, however, the roll axis is at the approximate level of the springs and hitherto stabilizers have not been fitted.



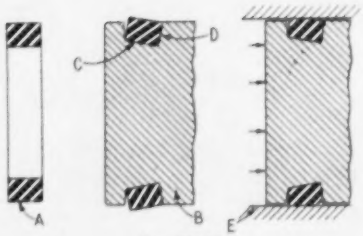
No. 728397

In the case of large buses or coaches the centre of gravity is usually relatively high and a high degree of stability is required on bends. It is difficult to provide the necessary stability since constructional considerations compel the use of a long, narrow frame and a narrow transverse spacing of the springs.

The torsion rod *A* is mounted, parallel to the axle, in the webs of the frame side members by means of rubber bushes *B*. These bushes are put under compression to grip the rod and press against the faces of the frame web by metal cups *C*. Lever arms *D* secured to the ends of the rod are linked to the axle or the spring assembly by means of rods *E* having rubber buffers *F* at points of connection. *Patent No.* 728397. *Daimler-Benz A.G. (Germany).*

Hydraulic seal

IT has been found that the frictional resistance to relative movement of hydraulic cylinder and piston elements under low fluid pressure is reduced by tapering the operative surface of the sealing ring. A ring having a frusto-conical surface is more costly to produce than one of rectangular cross section and, moreover, can be assembled in its groove with the lip end facing in the wrong direction. The invention circumvents these disadvantages by using a ring of rectangular cross section in a groove having a frusto-conical base



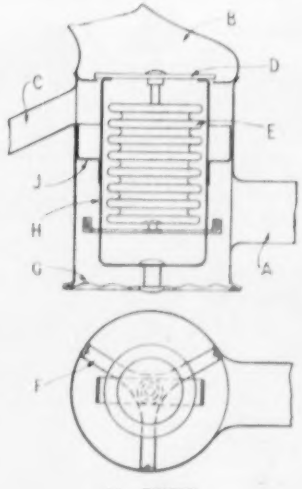
No. 726809

The sealing ring, of natural or synthetic rubber, is shown at *A* in its free or unstressed condition. In the piston *B* the groove is machined with a frusto-conical base *C* and an end wall *D*, remote from the pressure face, at 90 deg to the base to provide a rigid buttress for the ring. The leading end wall may be either radially or oppositely inclined. *Patent No.* 726809. *Girling Ltd.*

Compensated thermostat

THE device comprises a cylindrical casing from which branch inlet *A*, outlet *B* and by-pass *C*. Disc valve *D*, controlling the flow of coolant to outlet *B*, is actuated by the bellows-type, temperature-sensitive capsule *E* supported at its lower end on a bridge piece *F* secured to the casing. The lower end of the casing is closed by a diaphragm *G* which by means of a stirrup frame *H* and an axial stud is connected to valve *D*. In the example shown the frame *H* carries a slide valve *J* controlling the by-pass *C*.

With increasing coolant temperature the valve *D* is lifted by capsule *E* and the by-pass is closed by valve *J*. The hydrodynamic pressure of the coolant additionally loads the valve *D* in the opening direction and this pressure is the greater the higher the rotational speed of the engine. The same pressure exerted on diaphragm *G*, however, influences valve *D* in the opposite direction and, by appropriate design, it can be arranged for the two loadings to wholly or partially neutralize each other. *Patent No.* 727758. *Daimler-Benz A.G. (Germany).*



No. 727758

*'Syndromic' Automatic Lubrication soon pays for itself!

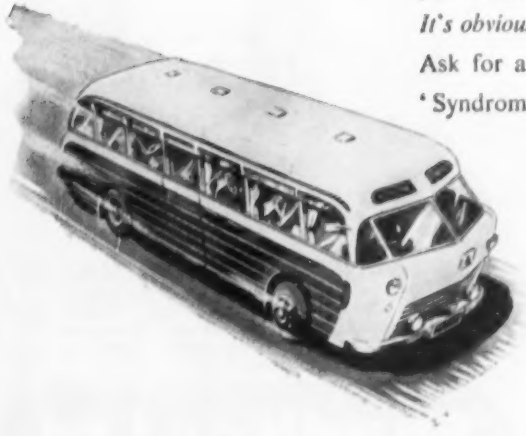
*INCREASES YOUR PAYLOADS 10%

From the moment you equip your vehicle with 'Syndromic' Lubrication it begins to pay for itself! First, it saves up to 75% on lubrication costs. Then, it ensures less wear on bearings because it automatically lubricates up to 80 bearings (using 2 pumps) at periods controlled by mileage. As a result, maintenance and replacement time and costs are kept down to a minimum.

But besides all that, 'Syndromic' lubrication saves the hours spent in the service bay. *It lubricates while the vehicle is working*, allowing you to increase your vehicles' payloads by as much as 10%!

It's obvious that 'Syndromic' lubrication soon pays for itself!

Ask for a Tecalemit technical representative to call and discuss the 'Syndromic' system with you.



TECALEMIT

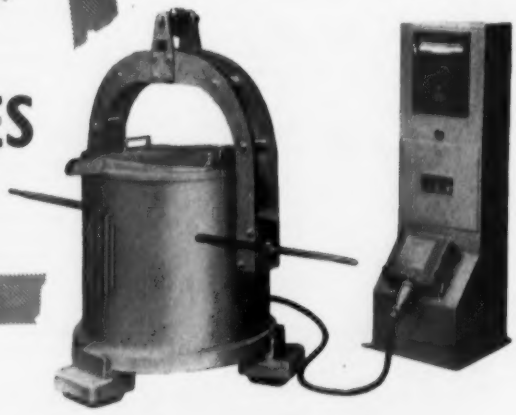
The Authority on Lubrication

PLYMOUTH, ENGLAND

T416

Model TM5A one-ton capacity tilting melting furnace.

Funditor
Electric
MELTING FURNACES
Tilting and Bale-Out Types



Model OM5 one-ton capacity bale-out melti g furnace.

ROBUST • ECONOMICAL • EFFICIENT
For melting lead, tin, zinc, white metal, babbit, solder, etc. Backed by 20 years' experience in all "soft" metal melting requirements. Modern design utilizing externally applied heating elements. Automatic temperature control. "Specials" constructed to order. Send for interesting leaflets of the various pots available.

3 WOODBRIDGE STREET, LONDON, E.C.1. Tel. CLERKENWELL 6155/7

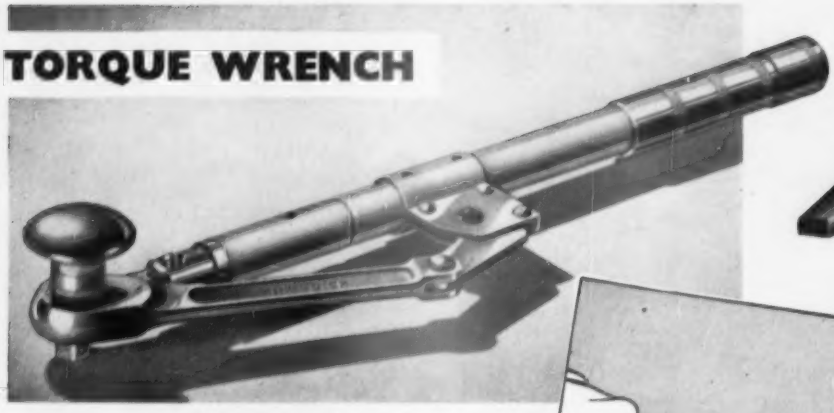
Funditor Ltd

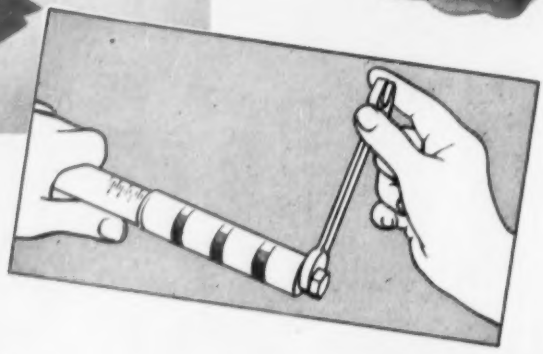
A screw and captive washer team up to form a single component ready for assembly. No tedious selection of screw and washer, no costly assembly, no missing or wasted washers. Choose Sems for efficiency, but to make certain of the best in quality and service be sure that they are made by Linread.

Linread

LINREAD LTD · COX STREET · BIRMINGHAM 3
Beardmore

TORQUE WRENCH





Equip with KING DICK !

Incorporated in the King Dick Torque Wrench is a ratcheting head which enables continuous tightening of bolts and nuts without the usual removal and replacement —a distinct advantage and time saver. All working parts are made from Chrome Vanadium Steel and heat treated, ensuring long life.
Literature is available which provides a schedule of recommended torque readings—please ask for copies or your local stockist will be pleased to give you details.

Our new 80 page catalogue is now available. Please write to Dept. A.E. for your copy.

BUY BRITISH

ABINGDON
KING DICK

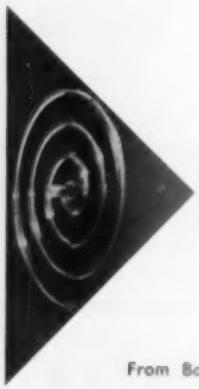
ABINGDON WORKS · KINGS RD · TYSELEY · BIRMINGHAM 11 · ENGLAND
R/C 185

An Up-to-date report on important branches of Plastics Technology

The technology of plastics grows rapidly and continuously. This book brings together some of the more important recent developments and contains chapters under the general headings of polymer structure and properties; expanded plastics; thermoplastics; extrusion; works study and productivity; injection moulding; patents; foundry resins and glass reinforced plastics. Many of these papers carry original investigations the result of which are appearing in print for the first time. The chapters themselves are based on the papers given at the British Plastics Convention, June, 1955, and not only are these papers given in full, which was not possible at the Convention, but a complete record of the discussions is also included.

$9\frac{1}{4}'' \times 6''$, 440 pages, over 140 illustrations, **50s.** net.
(By post **51s. 8d.**)

The illustration is of a typical test moulding described for the first time in this book



PLASTICS PROGRESS 1955

Papers and Discussions at the British Plastics Convention

From Booksellers or from Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1

PARK GATE

QUALITY STEELS
FOR THE MOTOR INDUSTRY

1823 EXPERIENTIA DOCET 1956

case hardening quality

for

gudgeon pins

THE PARK GATE IRON & STEEL CO. LTD., ROTHERHAM

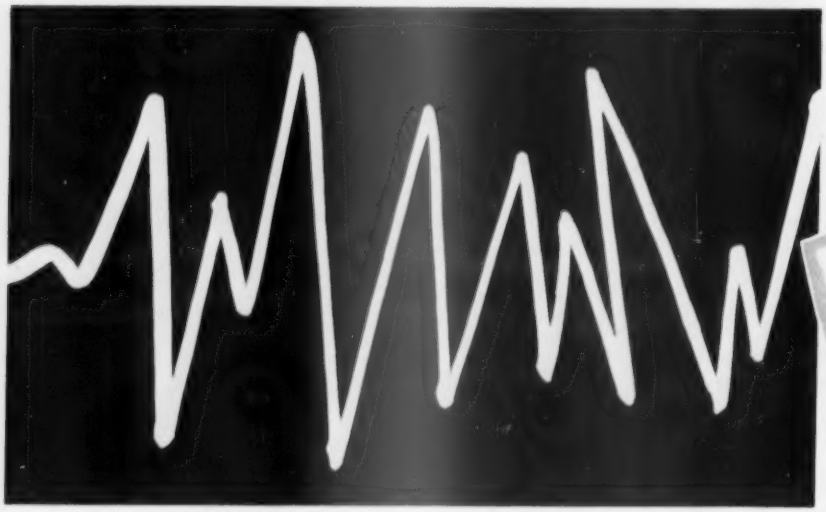
TELEPHONE : ROTHERHAM 2141 (10 lines) TELEGRAMS : YORKSHIRE, PARKGATE, YORKS

WE are privileged to number among our clients many of Britain's most famous car and commercial vehicle manufacturers. When next you require non-ferrous Sand Castings, Gravity Die Castings and Pressure Die Castings of the highest quality and precision, and keenly competitive in price — LET SANDWELL QUOTE. Our Technical Representative in your area will be pleased to call and discuss your requirements.

★ ILLUSTRATED LITERATURE ON REQUEST

SCC

THE SANDWELL CASTING CO.
BANK ST. FOUNDRY, WEST BROMWICH
Telephone : STOnecross 2231 (4 lines).
Telegrams : "REPCAST, WEST BROMWICH"

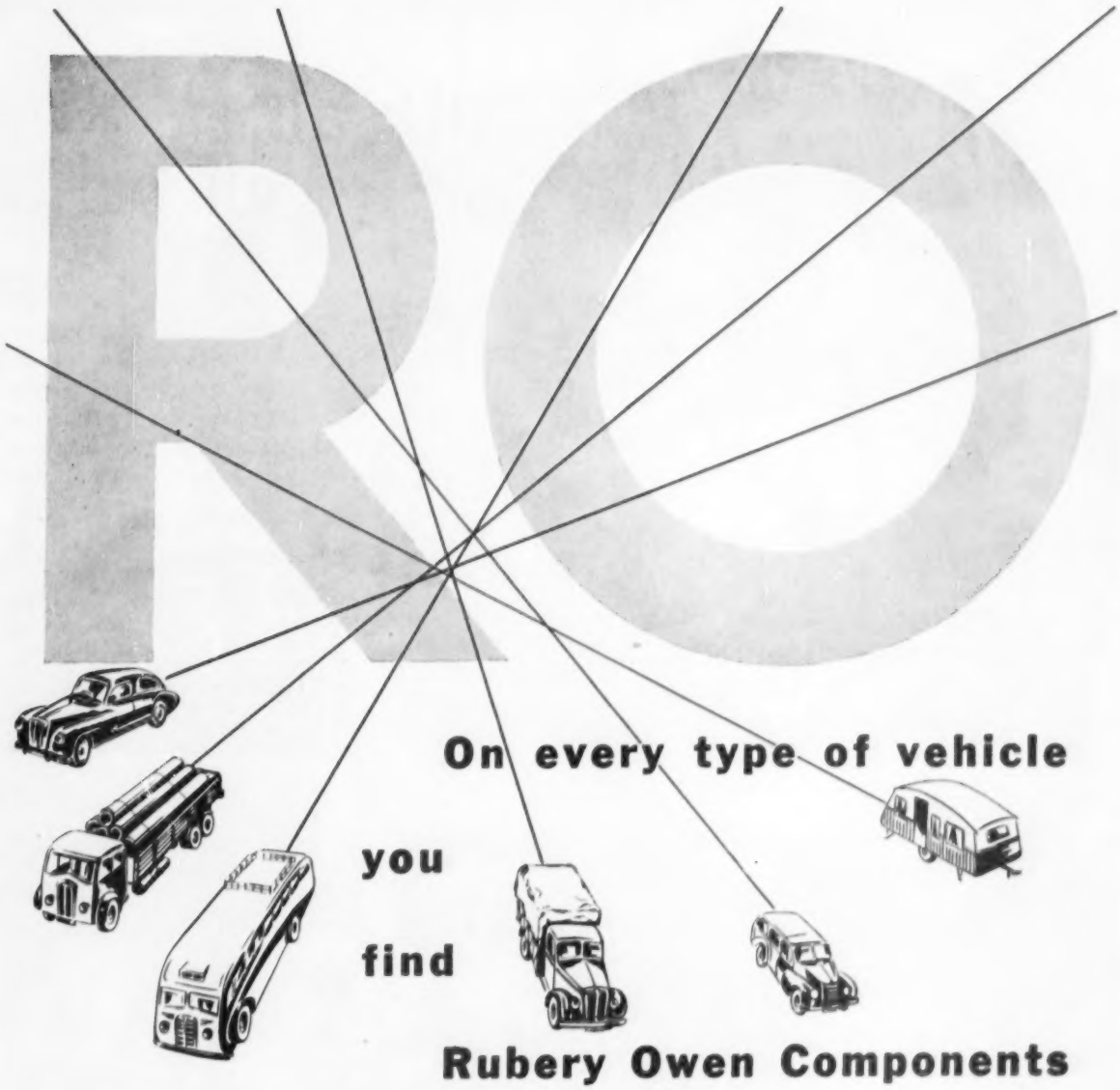


INDUSTRY IS Shocking

If you could calculate the loss of efficiency caused by machine vibration, you wouldn't wait to write to Cooper's, you would wire. When you realize that the Croid-Cooper method of machine installations also enables you to change layouts overnight—well, where's that telegraph form? We should also welcome your enquiry by telephone or letter.

COOPER & CO. (B'HAM) LTD., BRYNMAWR, BRECONSHIRE

Telephone: Brynmawr 312 Telegrams: Felting, Brynmawr

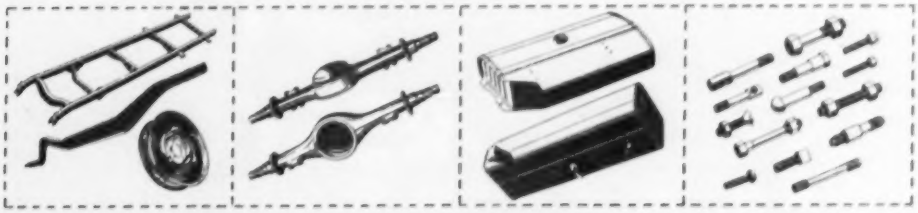


On every type of vehicle you find Rubery Owen Components

Buses, cars, lorries, produced in a vast range of designs and types and each requiring many vital component parts in their construction.

It is to meet this immense production output that Rubery Owen has developed from the early days of automobiles, an organisation ranking amongst the largest in the country.

Whatever the future trends are, R.O. will be sure to play their important part in them.



Remember too, that our Wrexham factory specialises in the manufacture of all types of Storage Equipment for Spares and Service supplies and Steel Pallets for keeping production on the move.

RUBERY OWEN COMPONENTS

RUBERY, OWEN & CO. LTD., P.O. Box 10, Darlaston, Wednesbury, Staffs. **Telephone : James Bridge 3131 (32 lines)**

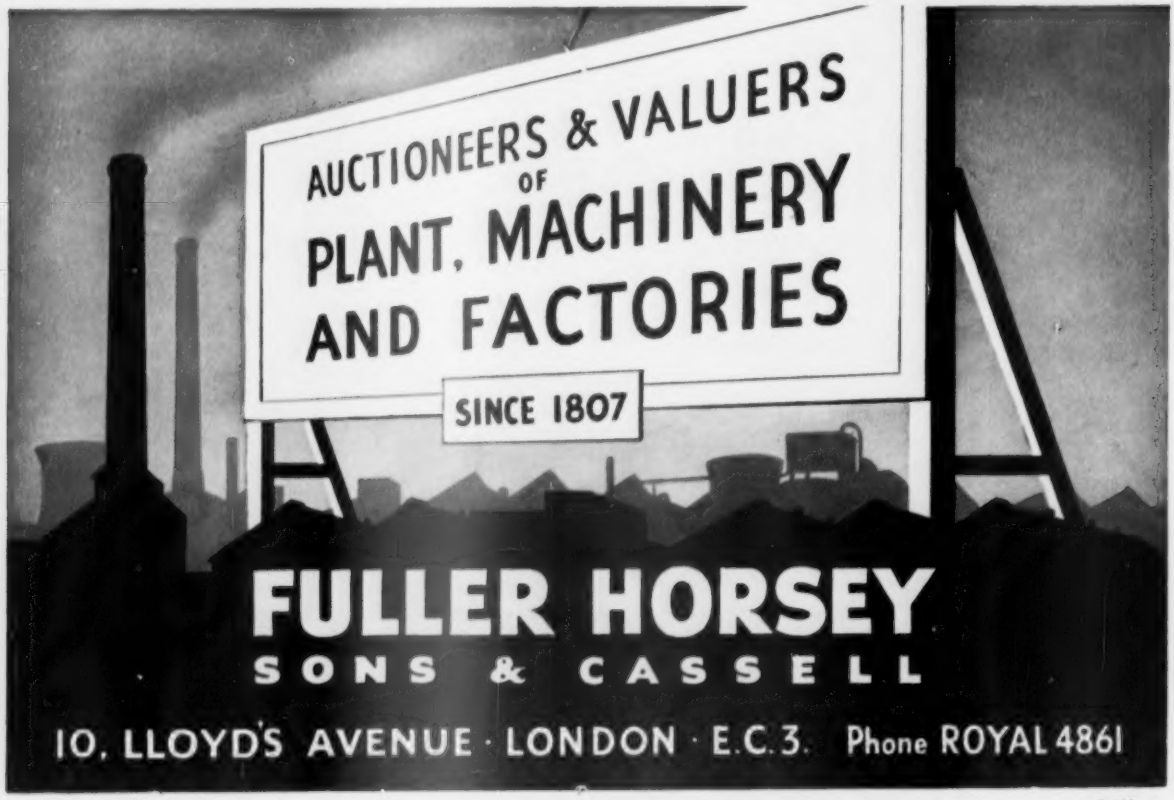
Member of the Owen Organisation.

it's all very well but...

When a pieceworker starts on 'ifs' and 'buts' about press guards, it is time you asked UDAL about the famous 'Fastrip' Synchronised Guards for *increased* production and *increased* safety. The 'Fastrip' is worked by compressed air and guard and clutch are synchronised to ensure split-second timing. Send for details today.

J. P. UDAL
LIMITED
INTERLOCK WORKS,
COURT ROAD,
BIRMINGHAM, 12
Telephone : CALthorpe 3114

Udal
PRESS GUARDS



Rathbone

Archdale 18" VERTICAL MILLERS

WITH FIXED OR SWIVEL HEAD . . giving a wide range of speeds for maximum production on all materials

With a range of 18 spindle speeds from 80 to 2,000 r.p.m. and four rates of automatic longitudinal table feed for each speed, these machines are capable of handling a very large range of work at fast rates. Table working surface 10" × 31". Maximum distance spindle nose to table 12 in.

N.B. Illustration shows the milling of valve bodies at Rubery, Owen & Co. Ltd., Darlaston.

JAMES ARCHDALE & CO. LTD., BIRMINGHAM 16 ● SOLE SELLING AGENTS: ALFRED HERBERT LTD., COVENTRY

soldering simply means FRY'S

If you have any problem connected with soldering, our Technical Department will be pleased to advise and assist you.

◀ Photograph shows operative applying solder to the roof and rear quarter assembly joint on the latest Riley "Pathfinder" saloon.

FMF
the inside story of HIGH SPEED QUALITY

Take a peep at the assembly-line for Riley "Pathfinders" and you'll find Fry's BELFRY solder in use all over the place.

Riley's rely on Fry's BELFRY solder to give them the first-class results the "Pathfinder" deserves. BELFRY solder is quick and clean and really cuts soldering costs. For a really superfine finish, specify ABBEY and BELFRY solders. Whatever the job — you can depend on Fry's.

EXPORT ENQUIRIES INVITED

FRY'S Metal Foundries Limited

TANDEM WORKS, MERTON ABBEY, LONDON S.W.19. *Phone: MITcham 4023*

and at MANCHESTER · GLASGOW · BRISTOL and DUBLIN MRP.2

CRANKSHAFT BALANCING
JACKSON & BRADWELL MODEL I.E. ELECTRONIC BALANCING MACHINE

The Austin Motor Co. Ltd. are using Model I.E. dynamic balancing machines for testing Series 'B' crankshafts where electronic indication has proved to be not only exact but highly expeditious.

- *Electronic Indication affords speed with accuracy.*
- *Direct readings can be taken in any plane along the component.*
- *Amount of unbalance and angular position easily traced.*

WRITE FOR ILLUSTRATED LITERATURE

BALANCING FOR THE TRADE:—
Electronic Balancing can be undertaken for weights from 5 lbs.—600 lbs. and lengths up to 5 ft. Contact:—
BALANCING & TECHNICAL SERVICES
—(dept. of Jackson & Bradwell Ltd.)

JACKSON & BRADWELL LIMITED

32 PARADISE STREET BIRMINGHAM

Telephone MIDland 4770 Telegrams Expert Birmingham

dm JK9.

CASTINGS TO CROW ABOUT

And you'll get them good and early from Gloucester

YOUR grey iron castings always come up to scratch when you get them from Gloucester Foundry. This is one of the most advanced foundries in Europe, supplying very large outputs of castings to the railways, the automobile industry, agricultural machinery makers, and many other leading engineering and allied industries. You get castings on time, consistent in quality, and keenly priced. Why not let Gloucester quote for your next castings in grey iron, 'Blackheart' malleable, or special alloy irons? A Gloucester casting specialist is always ready to call on you and advise on casting design to help save both time and money.

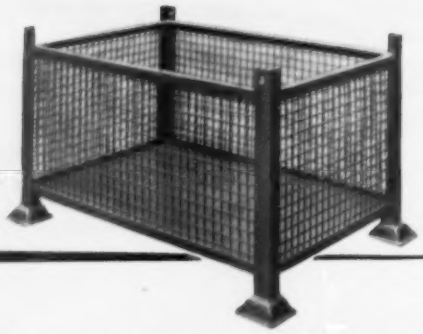
Give the job to

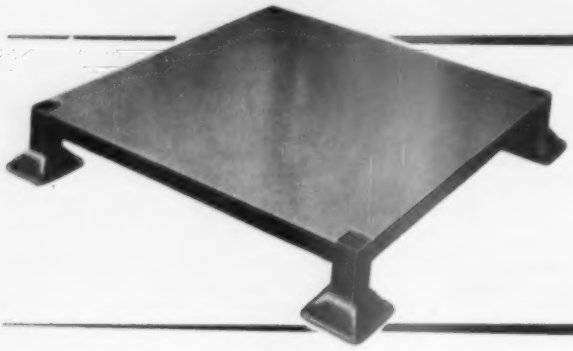
GLOUCESTER

GLOUCESTER FOUNDRY LTD., EMLYN WORKS, GLOUCESTER
(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)

Telephone: Gloucester 23041 Telegrams: 'Pulleys' Gloucester

Material handling auxiliaries





to your own requirements

GIRDEX material handling auxiliaries can be designed to handle your product and fit into your production system. We specialise in 'specials' and will be pleased to quote for your individual requirements.

GIRDEX

GIRDEX ENGINEERING CO. LTD., WESTON LANE, TYSELEY, BIRMINGHAM 11

Telephone : ACOcks Green 2205 Telegrams : GIRDEXPRES

G55

What they say about Duaflex . . .

Mr. J. Thompson, Workshop Foreman of Goode & Cooper Ltd., of Brixton, S.W.9, shown above talking to a driver, writes as follows :

"I am writing to tell you how satisfied we are with Duaflex Oil Control Rings. From the first time of fitting Duaflex several years ago we were aware of their superiority over other rings of this type. We operate a fleet of nearly 100 Taxi-Cabs in the London area, and at some time or another in the last few years they have all been fitted with Duaflex, giving an extended 30/40,000 miles life, between re-bores. I feel sure I can recommend them to all users. I have done so and will continue to do so."

This firm of taxi-cab operators gets a bonus of

3,000,000 extra miles between re-bores

through fitting Wellworthy Duaflex Oil Control Rings

Nearly 100 taxi-cabs all fitted with Duaflex Oil Control Rings, and each giving some extra 30/40,000 miles of life between re-bores — that's a total of about 3,000,000 extra miles of running on the credit side! No wonder Messrs. Goode & Cooper Ltd. of Brixton are well satisfied with their decision to standardise on Duaflex.

Duaflex Rings are suitable for both reconditioned engines and those not yet worn enough to call for a major overhaul but using an excessive amount of oil. In the latter event, Duaflex Rings can reduce oil consumption by as much as 80/90% — or even more — as well as improving compression and reducing the rate of wear in the bore. The Duaflex Ring compensates for wear by expanding in two directions and creating a gas and oil-tight seal. Even better results are obtained, of course, by fitting new Wellworthy pistons at the same time as Duaflex Rings.

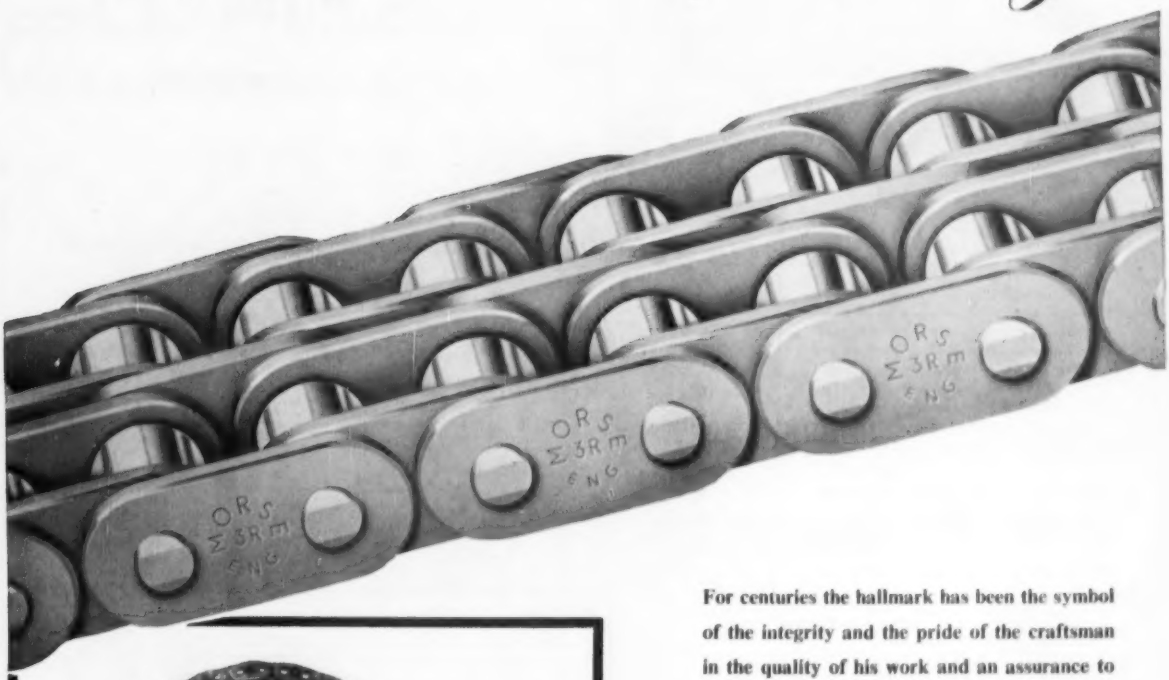
WELLWORTHY

DUAFLEX OIL CONTROL RINGS

REDUCE OIL CONSUMPTION · INCREASE COMPRESSION · DEFER RE-BORES

Please write for literature to : WELLWORTHY LIMITED · LYMINGTON · HANTS

The Hallmark of Quality



Crankshaft & Camshaft sprockets and chain as fitted to the Hillman-Minx. Morse ½" pitch single, duplex and triplex Roller Chains are available for all engine manufacturers.

For centuries the hallmark has been the symbol of the integrity and the pride of the craftsman in the quality of his work and an assurance to the user that he has a product upon which he can rely. In the same way, the word "Morse" stamped on each link of every Morse Chain symbolises and guarantees the quality of material, the precision manufacture and the long experience which have made Morse the leader in the field of chain engineering.

This is why famous manufacturers throughout the world specify Morse Chains for their equipment.

MORSE

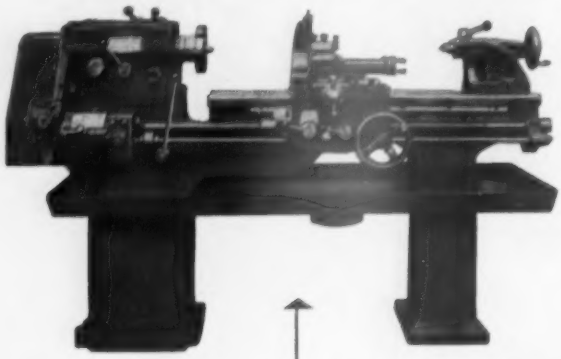
timing chains

A BORG-WARNER PRODUCT

B-W

MORSE CHAIN DIVISION, BORG-WARNER LIMITED, LETCHWORTH. *Tel: LETCHWORTH 1833*

MANUFACTURERS OF AUTOMOTIVE TRANSMISSIONS AND MORSE CHAINS



Woodhouse & Mitchell

'70' junior 7" centre lathe

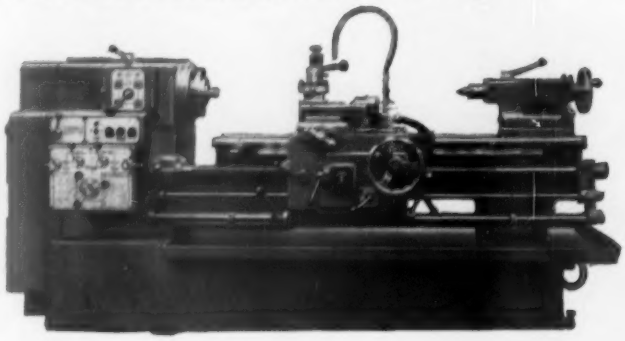
'85' 8½" centre lathe

Proprietors: Thos. W. Ward Limited

WOODHOUSE & MITCHELL · Wakefield Rd. Brighouse. 'Phone 627

8 SPINDLE SPEEDS 30—874 r.p.m. Spindle mounted on selected taper roller bearings • Diagonally braced bed • Nickel steel gears on multi-splined shafts • Inverted vee and flat guides • Single lever selection of feeds • Tension mounted lead screw • Oil immersed multi plate clutch.

12 SPINDLE SPEEDS 21—945 r.p.m. Rigid one piece fabricated steel base • Rapid spindle speed selection • Feed reverse control from apron • Totally enclosed auto lubricated quick change feed gear box.



Send for fully illustrated booklet.

W.H.17.

In the words of Shakespeare:

"I wish your enterprise today may thrive"

"Julius Caesar" Act III. Scene I.

Unlike Popilius we do not stop at wishing you success, we want to help you to achieve it, and that we can do with the "POP" riveting system. This modern, and most efficient of riveting systems enables riveting to be done in one operation, by one operator working from one side of the material only, giving an increase in production and saving in man-power that will make your enterprise thrive.

Consult our technicians on all your riveting problems.

'POP' RIVETING
ONE OPERATOR OPERATION

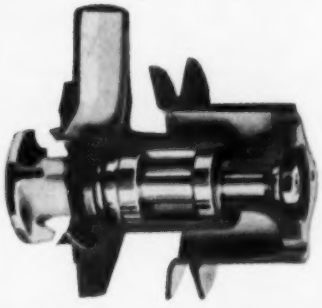
Geo. **TUCKER EYELET** Co. Ltd.
Walsall Road · **BIRMINGHAM 22**
Telephone: Bilfchfields 5024 (7 lines) Telegrams: EYELETS, BIRMINGHAM
Consultants & Tool Manufacturers:
AIRCRAFT MATERIALS LTD. Midland Road, London, N.W.1
"POP" is a regd. Trade Mark of Geo. Tucker Eyelet Co. Ltd.

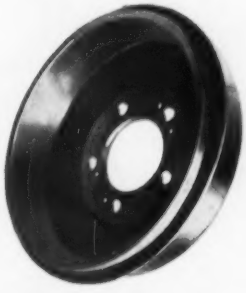
THE MODERN SYSTEM OF RIVETING

CONSISTENT *ACCURACY* . . .
CONSCIENTIOUS *SERVICE* . .
CONVINCING *PERFORMANCE*.

CONCENTRIC COMPONENTS

Precision Parts that meet the highly specialized requirements of the Car and Commercial Vehicle Industries





WATER PUMPS · STEERING IDLERS · GEAR CHANGE MECHANISMS · BRAKE DRUMS PUSH RODS . BALL PINS · SHACKLE PLATES THRUST PLATES AND ASSEMBLIES · MACHINED COMPONENTS OF ALL KINDS

Manufactured in a modern factory specially designed and equipped to produce a better job in less time and at lower cost.

Concentric
MANUFACTURING CO. LTD.
TYBURN ROAD. BIRMINGHAM 24

Telephone : EASt 2081-2-3-4-5.
Telegrams : "Accelerate," Phone Birmingham.

Can you afford to ignore this low cost protection?

Of course not! No business man can afford to stand by while his profits are being eaten away by rust. And make no mistake, rust *will* waste your metal and labour costs unless you do something positive about it.

The RODOL range of rust preventives covers practically every aspect of temporary rust prevention. Between them, the 22 RODOL grades give the right degree and type of protection required by any metal or component and for any period of time from a few hours up to six months. Write today for details or samples of these invaluable products.

RODOL RUST PREVENTIVES

FLETCHER MILLER LTD · ALMA MILLS · HYDE · CHESHIRE

Telephone: HYDE 781 (5 lines) Telegrams: EMULSION, HYDE

R 20

MARSTON RADIATORS

ICI

Marston Excelsior Ltd
Wolverhampton & Leeds
(A subsidiary company of Imperial Chemical Industries Ltd.)

for the BENTLEY 'S' SERIES SALOON

Down to the very last detail, nothing but the highest quality materials and components are used for the latest Bentley Saloon. That is why its makers, like Britain's other leading car manufacturers, fit a Marston radiator as standard equipment. Renowned for their supreme reliability and efficiency, Marston Radiators are *in front of the finest.*

MAR 159A

What next . . . in NON-FERROUS CASTINGS?

The runner and other castings have been made by Birkett, Billington & Newton Ltd. for this 750 H.P. Pelton Wheel Generator supplied to the New Zealand Government by Gilbert Gilkes and Gordon Ltd., of Kendal.

Casting this water turbine runner in a single piece from aluminium-bronze was a considerable achievement.

Birkett, Billington & Newton Ltd. were able to tackle the job because they have specialised in the development of this metal, and their unrivalled experience and facilities enable them to carry out such problematic non-ferrous castings.

Aluminium-bronze has a high yield point and a low weight/strength ratio, and is very resistant to shock, erosion, corrosion and abrasion.

Castings from a few ounces to 10 tons in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys. Precision-machined bushes and bearings. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, and chill-cast rods and tubes.

One of Britain's Largest Non-Ferrous Foundries

BIRSO TRADE MARK BN

T. M. BIRKETT, BILLINGTON & NEWTON LIMITED

HANLEY AND LONGPORT, STOKE-ON-TRENT

Head Office: HANLEY, Phone: Stoke-on-Trent 22184-5-6-7. LONGPORT FOUNDRY: Phone: Stoke-on-Trent 87303.

Daimler

USE

CLANCEY

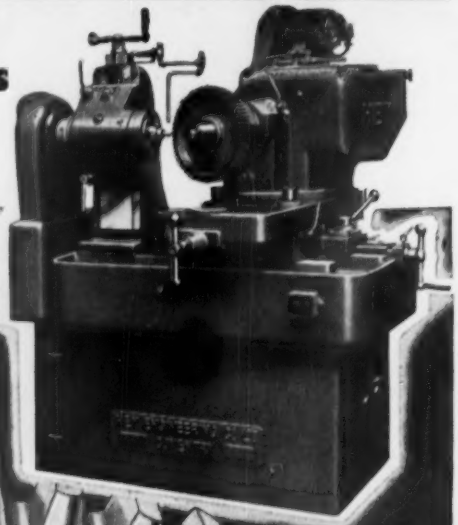
CAST-IRON VALVE GUIDES
AND
CHILLED-FACED TAPPETS

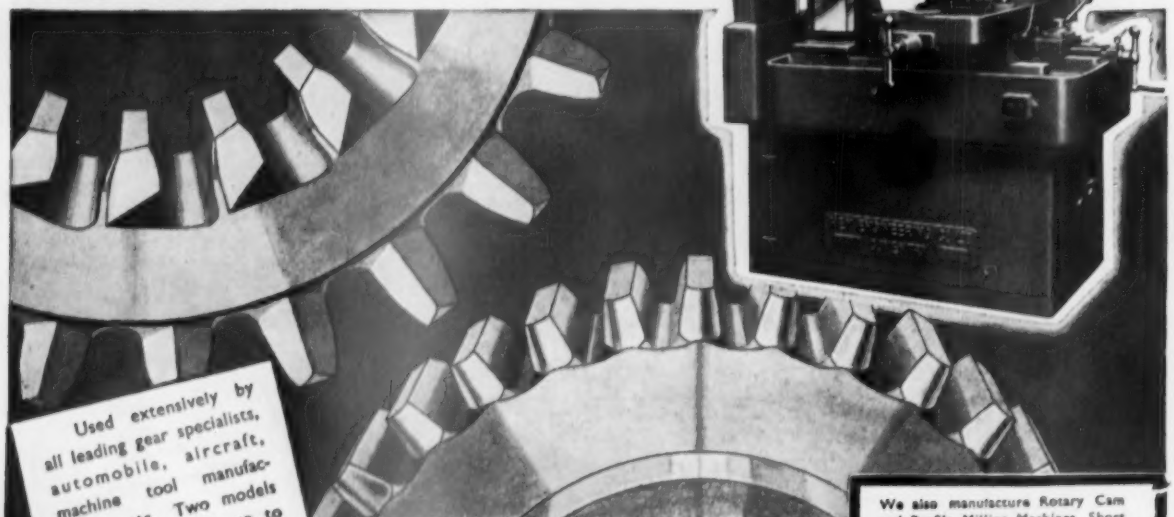
G·CLANCEY LTD · BELLE VALE · HALESOWEN
TELEPHONE: CRADLEY HEATH · 69411-2-3

HEY

GEAR TOOTH ROUNDING
and CHAMFERING MACHINES

Automatic Operation, High Production Rates on External and Internal Gears, Starter Rings, etc.





Used extensively by all leading gear specialists, automobile, aircraft, machine tool manufacturers, etc. Two models available for work up to 20in. and 10in. diameter. Illustrated data on request.

HEY ENGINEERING CO. LTD.
COVENTRY PHONE COVENTRY 88641

We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines, Multiple Drilling Heads and Machines, Tapping Machines, End Facing and Centring Machines, Special Machine Tools for High Production.

Rainbow

Small details make a big difference in handling automotive parts

Only the diesel-electric power of Coles gives that smooth, exact control vital to precision handling

Power from the Coles diesel-electric transmission makes possible high speed in the most accurate handling. Slow creeping speeds ensure exact positioning when required, whilst fast acceleration and high maximum speeds make for big daily output.

Coles move quickly from job to job, manoeuvre easily in crowded areas and carry loads to and from storage sheds, passing easily through low doorways and stacking to exceptional heights.

In-built automatic safety controls protect men and loads from accident and ensure that every job you give the Coles will be carried out quickly and safely.

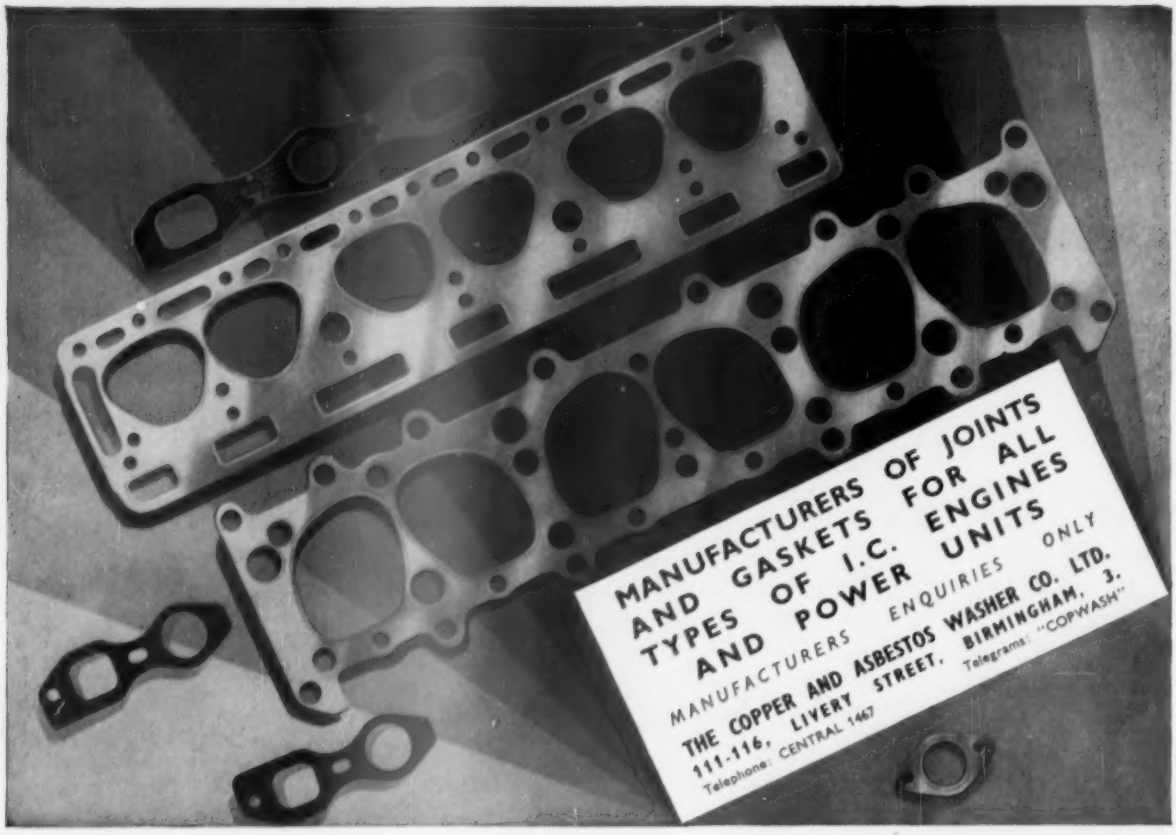
COLES

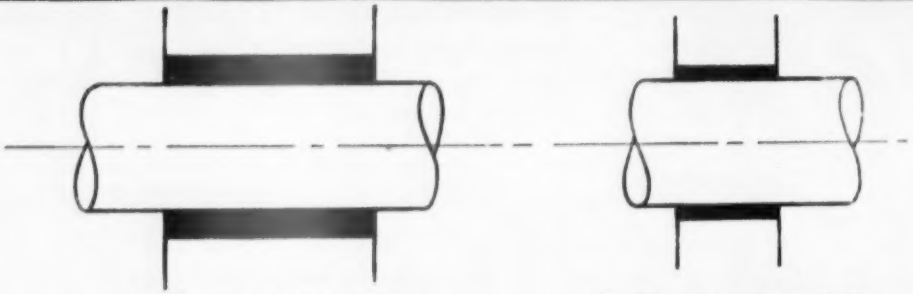
THE NAME THAT CARRIES WEIGHT

Designed, manufactured and marketed by:—

STEELS ENGINEERING PRODUCTS LTD.

CROWN WORKS, SUNDERLAND, CO. DURHAM. *Tel: Sunderland 56281 (10 lines). Grams: Steel, Sunderland.* **SALES & SERVICE: BIRMINGHAM:** 39 Thorp Street, 5. **GLASGOW:** 235 Bath Street, C.2. **LONDON:** 6 Avonmore Road, W.14. **MANCHESTER:** 153 Oxford Road, 13. **NEWCASTLE:** Brunswick House, Brunswick Place.


MANUFACTURERS OF JOINTS AND GASKETS FOR ALL TYPES OF I.C. ENGINES AND POWER UNITS
MANUFACTURERS ENQUIRIES ONLY
THE COPPER AND ASBESTOS WASHER CO. LTD.
111-116, LIVERY STREET, BIRMINGHAM, 3.
Telephone: CENTRAL 1467
Telegrams: "COPWASH"



Long and thick-walled Bushes are a waste of material.

Short and thin-walled Carobronze Bushes save material and are more efficient.

CAROBRONZE BRAND COLD-DRAWN PHOSPHOR BRONZE TUBING

possesses a high load capacity and excellent physical properties which enable Bearing Bushes to be made both shorter and thinner than is frequently the case.

As the machining allowances necessary with Carobronze are likewise very small

. . . . ***YOU SAVE IN EVERY DIRECTION***

CAROBRONZE LIMITED

School Road, Belmont Road,

London, W.4.

Phone: Chiswick 0245

Grams : Carobronce-Chisk, London

- *Available from stock*
- *Totally enclosed fan cooled*
- *End windings taped to give inter-phase insulation and rigidity*
- *Six leads brought out to terminal box*
- *Outputs up to 25 h.p.*
- *Double impregnation*
- *For normal duty in any part of the world*
- *Standard dimensions to B.S. 2083 (1954)*

built to last

G.E.C.

motors

Ask for Technical Description No. 431

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

Here's a fast worker for you

One of the many contributions we have made to the cause of quicker assembly is the vibration-proof sems fastener. It is supplied complete with captive washers of various types; is easy to handle, easy to drive, makes a permanent fastening and simplifies stock control. All this means less time wasted and faster production.

If it's a matter of how to fasten one thing to another . . . get in touch with GKN

GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD., BOX 24, HEATH STREET, BIRMINGHAM s/gkn/3001

Chas. Clifford Birmingham

'TELFOS' BRONZE — Chemical Composition, approx. 95% Copper, 5% Tin, ·02 - ·4% Phos; Tensile, 30 - 45 Tons per sq. in; Elongation, 15 % - 20%; is a similar metal to Phosphor Bronze, yet possesses the remarkable advantage of machining three times as freely.
Write to us for a copy of our Descriptive Folder.

TELFOS BRONZE

REG. TRADE MARK

Free Machining Wrought Alloys

RODS AND BARS
Round, square, flat and hexagon.

saves labour...
speeds production...
cuts costs...

Charles Clifford Limited, Dog Pool Mills, Birmingham 30 *Offices: London Glasgow & Dublin*

M-W.1225

GLACIER

Bearings and Bushes

We make an astonishing variety of plain bearings. In fact, more than 3,000 different designs of bearings and bushes are going through our factories at any given moment. We supply thin-walled bearings to the motor industry and other engine builders, thick-walled and heavy bearings to the makers of compressors, pumps, turbines, rolling mills, marine and stationary diesels. In short, we make all types of bearings for all industries.

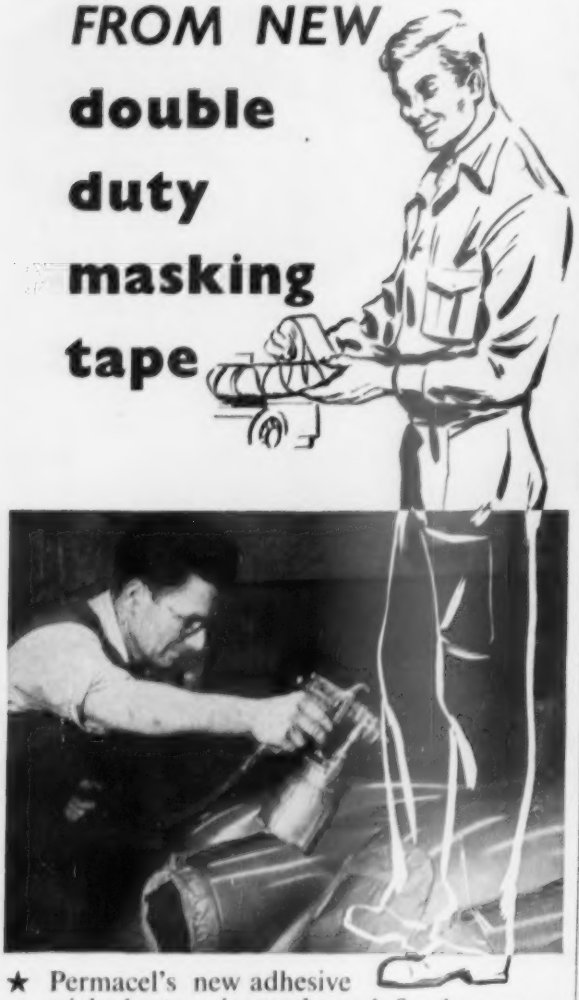
THE GLACIER ORGANISATION includes 3 production factories, 3 service stations; over 347,000 square feet of floor area, employing nearly 3,000 people, producing bearings and bushes in sizes from ⅛" to 4 ft. diameter, in value from 2d. to £300 each, serving thousands of customers in engineering and many other industries all over the world.

GLACIER

the largest makers of plain bearings in Europe.

THE GLACIER METAL COMPANY LIMITED, ALPERTON, WEMBLEY, MIDDLESEX, ENGLAND

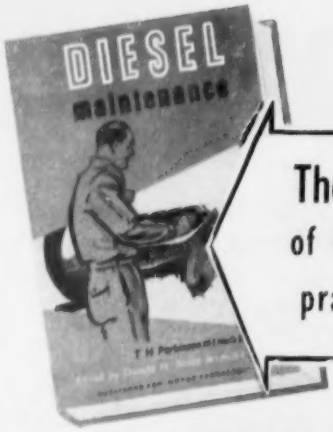
YOU CAN PROFIT FROM NEW double duty masking tape



★ Permacel's new adhesive sticks better—instantly and firmly to any surface, rough or smooth.
★ Clean line of demarcation. Permacel keeps all paint off protected areas.
★ Permacel sticks firmly and strips off cleanly, without affecting painted surfaces.
★ Permacel's extreme thinness prevents paint build-up at edges.
★ Permacel is skin flexible. Get around awkward contours and uneven surfaces.
★ Permacel is unaffected by chemicals and solvents.
★ Write for your free copy of the Permacel Guide to over 400 uses for Permacel Self-Adhesive Tapes to Dept. A.E., Industrial Division.

PERMACEL
TRADE MARK
SELF-ADHESIVE TAPES

Johnson & Johnson (GT. BRITAIN) LTD., SLOUGH, BUCKS.



The 4th Edition of this essentially practical manual

Diesel Maintenance: A Practical Guide to Servicing the Modern Automotive Diesel Engine

By T. H. Parkinson, M.I.Mech.E.
Edited by Donald H. Smith, M.I.Mech.E.

This well-known handbook is indispensable to all responsible for the maintenance and servicing of diesels of the automotive type; injection equipment in particular is dealt with in great detail. There is much on various aspects of fleet operation while the practical mechanic can obtain information from this book that he could scarcely acquire in several years of workshop practice. 8¼" × 5½" 216 pp. 123 illustrations.

12s. 6d. net. *By post 13s. 4d.*

Obtainable from booksellers or direct from:
ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD ST, LONDON, S.E.1

Don't SPECULATE on springs

You WILL get the best from LITCHFIELD BROTHERS

LITCHFIELD BROTHERS LTD.
BROADHOLME BELPER DERBYSHIRE

PHONE BELPER 234

cramping her style!

Dressing must have been a major operation for the Victorian woman. First her frilled, flounced underwear, followed by a straw and horsehair lined under-petticoat, followed by a flannel petticoat and then another horsehair horror! On top of this a stuffed wheel and yet three more petticoats. And these were only underclothes! *The heavy steel ring crinoline came on top.*

However complex and complicated your plastics problem seems to be—we at Ekco have the know-how and experience to offer you a perfect solution. Designing, tooling and moulding—we do it all under one roof. If you are thinking of using plastics you should get in touch with us at Southend.

EKCO

PLASTICS FOR INDUSTRY

E. K. COLE LTD. (PLASTICS DIVISION), **SOUTHEND-ON-SEA, ESSEX**
TELEPHONE: SOUTHEND 49491 (20 LINES)
(Members of the British Plastics Federation)

MEMO

VALVES, COCKS, STEAM TRAPS TUBES AND FITTINGS in all metals

from SCREWS to CEMENT MIXERS

It's so easy to stock through

Walkers

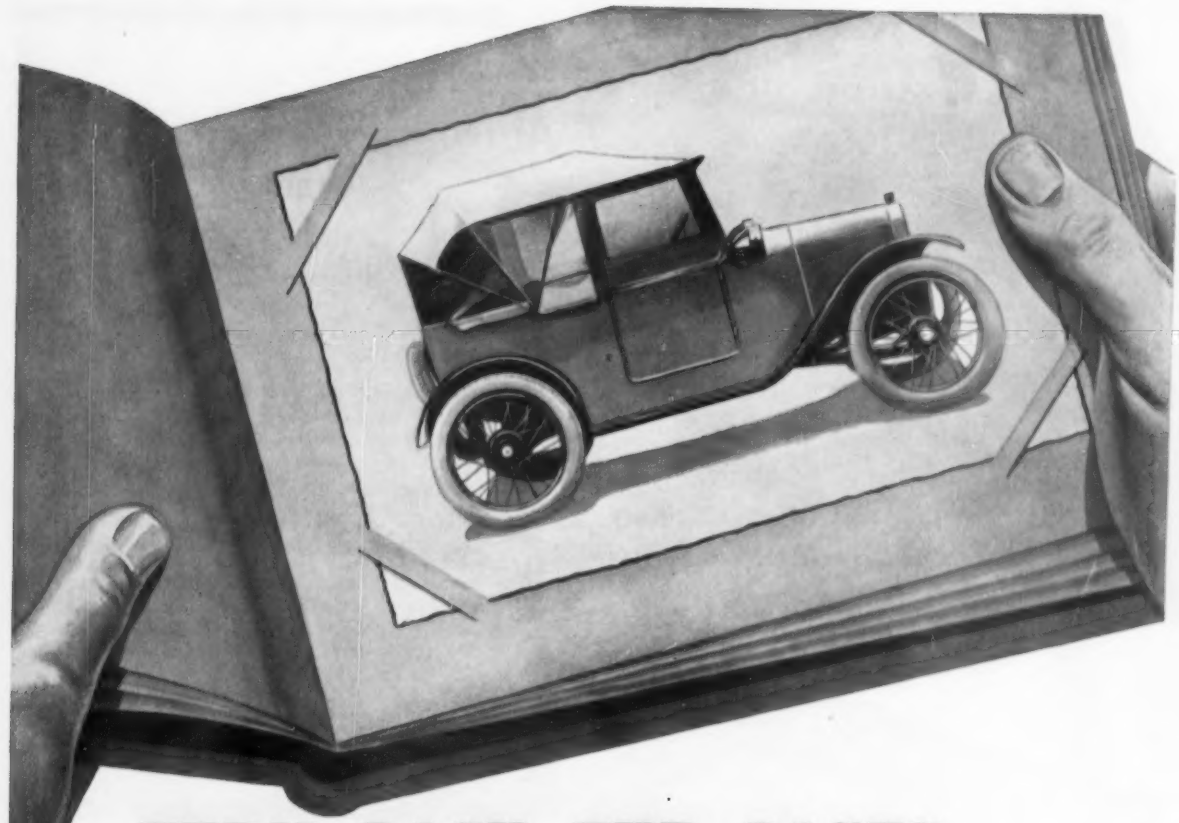
M. W. WALKER & STAFF LTD
ENGINEERS MERCHANTS
IBEX HOUSE, MINORIES, LONDON, E.C.3
'Phone ROYal 8191 (10 lines) 'Grams Makerlaw, Fen, London
Middle East Branch—Bahrain Persian Gulf

Taking the strain!

Movement, vibration, power stresses, these forces provide a constant tug-of-war with every bolt and nut. That is why engineers use Richards "Hi-Strain" bolts which take such strains with maximum safety. Supplied Heat Treated to B.S.S. 1083 and B.S.S. 1768 Grade R Quality 45/55 tons tensile. Threads to Whitworth B.S.F., U.N.F. and U.N.C.

RICHARDS
hi-strain BOLTS

CHARLES RICHARDS & SONS LTD., Darlaston, South Staffs.
Phone: James Bridge 3188 (8 lines) P.B.X. Wires: "Richards, Darlaston."



TURN BACK THE PAGES...

One of the most famous cars in the world—the well-loved 'Baby' Austin of the nineteen twenties.

Hardy Spicer first supplied 'Hardy' flexible couplings for the Austin seven in 1922.

Today AUSTINS, in common with the majority of modern motor manufacturers, fit Hardy Spicer propeller shafts and couplings to its successor the present day A.30, and their entire range of passenger cars and commercial vehicles.

HARDY SPICER

HARDY SPICER LTD · BIRCH ROAD · WITTON · BIRMINGHAM 6

(A Birfield Company)

Costs rising ?

Today's all too familiar trend of increasing costs can only be halted by making production more economical. But how to do so raises problems too. Fortunately, when it comes to Malleable Iron Castings your interests are our particular concern.

bring them down with—

The Blackheart Malleable Iron Castings we produce enable you to bring costs right down to earth. Production technique is such that castings are usually ready for immediate jig machining. Our castings conform to the Highest British Specification accepted—B.S.S. 310. (1947) Grade 3.

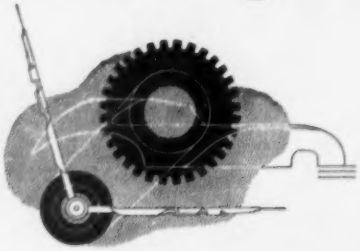
BLACKHEART *Malleable* IRON CASTINGS

SHOTTON BROS · LTD

OLDBURY, NEAR BIRMINGHAM

Telephone : BROadwell 1631-2

Books for Automobile Engineers



Your local Smith's shop or railway bookstall can quickly supply the books you want on any aspect of the industry. Lists of titles on specific subjects will gladly be supplied on request.

Your copies of AUTOMOBILE ENGINEER can be bound into attractive volumes; and all your stationery and printed matter supplied through our local branch.

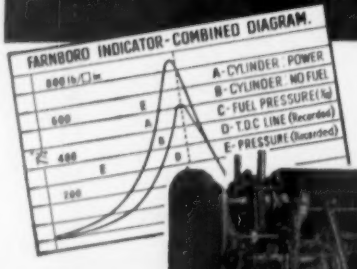
W. H. Smith & Son

for TECHNICAL BOOKS

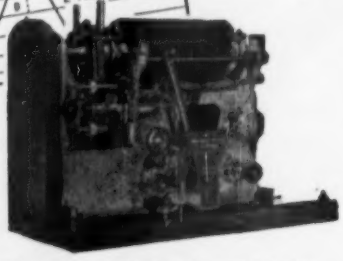
HEAD OFFICE: STRAND HOUSE, LONDON, W.C.2

DOBBIE McINNES

'FARNBORO' ELECTRIC INDICATOR



Large Diagrams up to $14\frac{1}{2}'' \times 7\frac{1}{2}''$



No complex electric circuits. Replacements are negligible. No glass components. Simplicity ensures ready understanding and manipulation without special knowledge. Very large diagrams. No Photography, thus saving time and trouble. Calibration Lines can be recorded while taking diagrams.

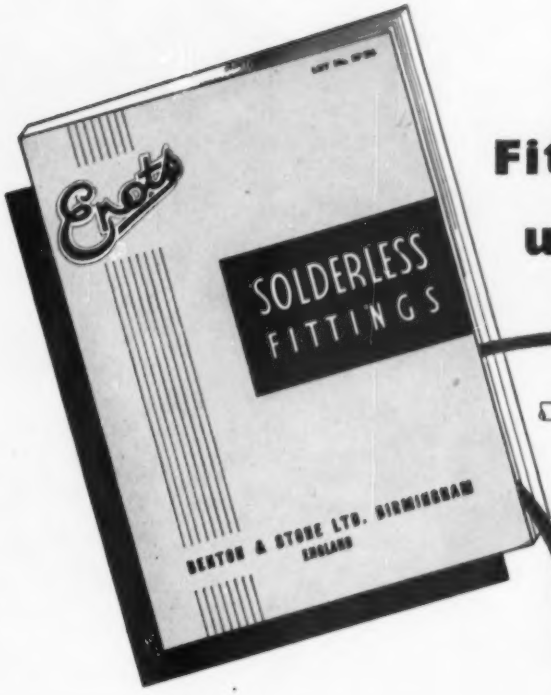
DOBBIE-McINNES

DOBBIE McINNES LTD

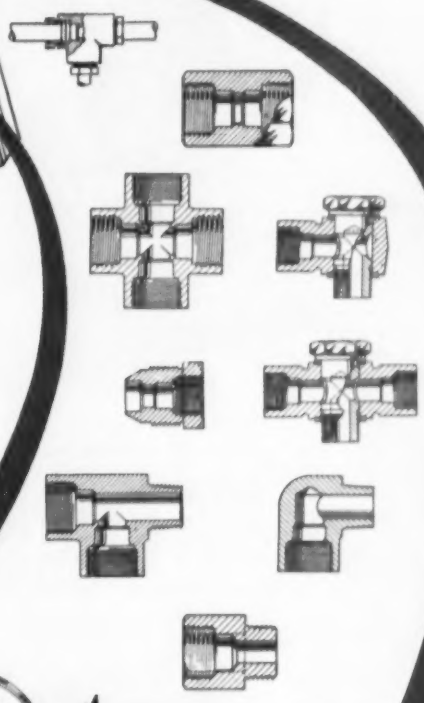
Makers of Engineering Instruments

BROOMLOAN RD GLASGOW SW1

Also at SOUTH SHIELDS · LIVERPOOL · LONDON



Fitted any good unions lately?



More and more manufacturers are standardizing on Enots brass solderless unions because :

(a) They make a 100% leak proof joint.

(b) Fitting and assembling costs are reduced.

(c) The range of some 700 components caters for outside diameter tube sizes from ¼" to 1¼" and for pressures from 4,000 to 1,000 lb. per square inch, according to size.

(d) They are specially suitable for compressed air and hydraulic circuits.

Enots standard pressure gauge (0-160 lb. per sq. inch) fitted with solderless nut and sleeve which enables gauge to be tightened into position and facing in any required direction without all the usual troubles always experienced when the gauge is screwed.

Enots

SOLDERLESS UNIONS

We invite you to send for our catalogue SF854 which also includes details of copper, Bundy steel and flexible tubing.

BENTON & STONE LTD · ASTON BROOK STREET · BIRMINGHAM 6 · ENGLAND

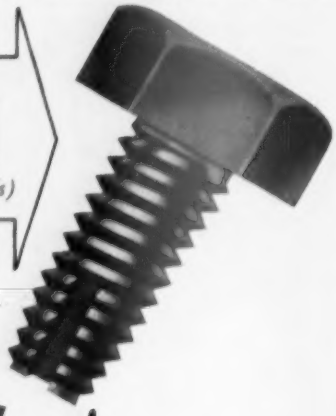
See our Exhibits at The International Machine Tool Exhibition 1956, June 22—July 6, Olympia, London.

"SHAKEPROOF"
REG. TRADE MARK Nos. B611535
THREAD CUTTING SCREWS
British Patents Nos. 186895 · 551478

Cut their own machine screw thread

FOR GREATER STRENGTH & FASTER ASSEMBLY

FOR METAL
TYPE 1
(All standard threads)



FOR DIE CASTING
TYPE 23
(All standard threads)

FOR PLASTICS & SHEET METAL
TYPE 25
(Special coarse pitch thread)

A.I.D. APPROVED

BARBER & COLMAN LTD
MARSLAND RD · BROOKLANDS · MANCHESTER
TELEPHONE: SALE 2377 (3 LINES)
TELEGRAMS: "BARCOL" SALE

"SHAKEPROOF" PRODUCTS

Factors' and Dealers' enquiries to:- Wm. Clark (Spare Parts) Ltd., 438 Harrow Road, London, W.9.

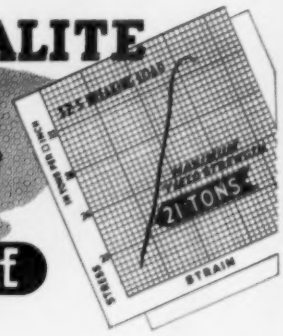
S.B.2

MANY ENGINEERS ALWAYS SPECIFY

PERMALITE

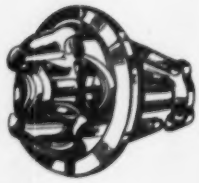
the high tensile

MALLEABLE



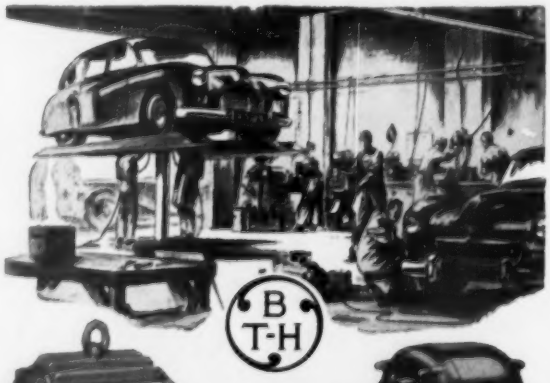
Mechanical properties:—

- ULTIMATE TENSILE STRENGTH 33/35 Tons per square inch.
- YIELD STRENGTH 20/22 Tons per square inch.
- ELONGATION 6% to 8%.
- BEND 90°.
- BRINELL VALUE 175.



Write for details

HALE & HALE (TIPTON) LIMITED DUDLEY PORT Staffs



B T-H

ELECTRIC EQUIPMENT for Garage and Workshop

A.C. and D.C. Motors
Starters and control gear
Automatic pressure switches
Mazda lamps and lighting equipment

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND
Member of the A.E.I. group of companies

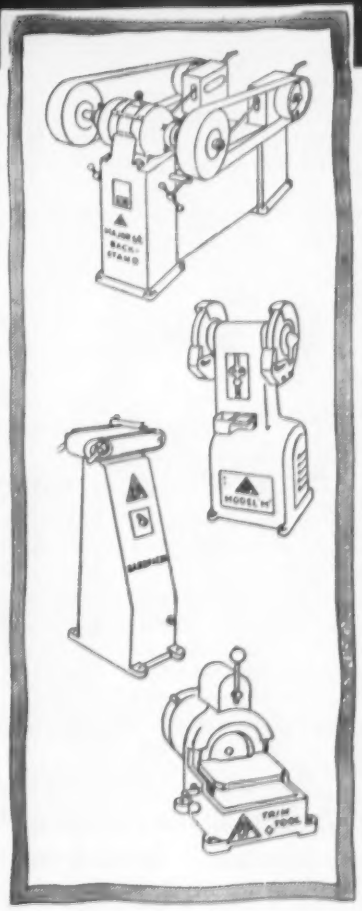
A.6857

Specialists

IN GRINDING & POLISHING

To meet the increasing need for higher standards of finishing throughout every industry R.J.H. have specialised for years to produce a range of Backstands, Bandfacers and Grinders to fit all requirements. The success of this aim is proved by the growing number of manufacturers who are reducing costs and increasing quality by using R.J.H. equipment.

We will be pleased to send on request literature covering complete range of equipment.



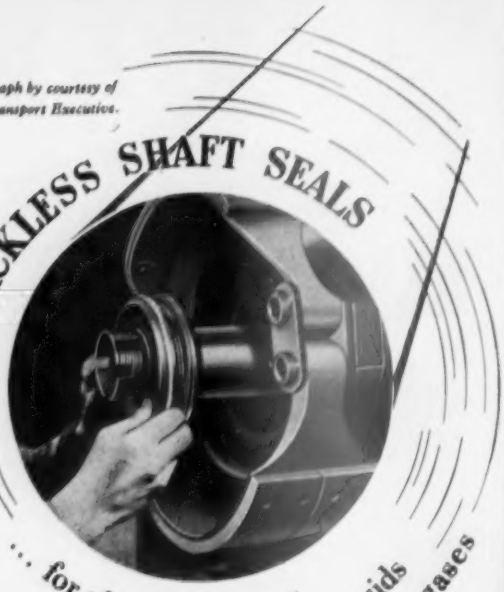
R. J. H. TOOL & EQUIPMENT CO. LTD.,
HECKMONDWIKE, YORKSHIRE
Telephone : Heckmondwike 490.

London & Southern Counties Representative:
E. J. SPREADBOROUGH, A.I.Mech.E., 30, Heath Street, N.W.3. Telephone: Ham. 8037.

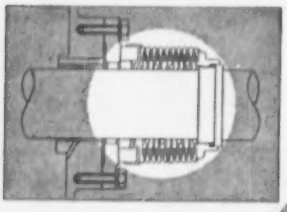
INTERNATIONAL MACHINE TOOL EXHIBITION 1956, OLYMPIA,
June 22nd. — July 6th.
STAND No. 511, EMPIRE HALL GALLERY.

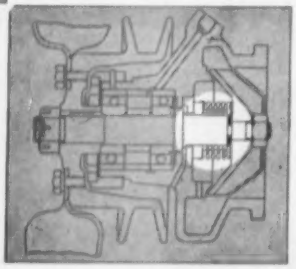
Teddington

Photograph by courtesy of London Transport Executive.



TEDDINGTON Shaft Seals are ideal for shafts running at speed. For example a 3½" dia. shaft running at 2,000 R.P.M. in temperatures up to 300°F is quite normal. As peripheral speed of the rubbing surfaces is the deciding factor, they can be fitted to larger shafts running at lower speeds or to smaller ones at high speeds. They will retain most liquids or vapours at pressures from 30-in. vacuum to 250 lbs. per sq. in., and are unaffected by continuous or intermittent running, or reversing.





The British Thermostat Company are the largest manufacturers of metallic bellows in Europe and, during the last 25 years, have acquired unique experience in the design and application of metallic bellows and packless shaft seals. Write for Leaflets NS.5 and NS.33.

THE BRITISH THERMOSTAT CO. LTD.
SUNBURY - ON - THAMES, MIDDLESEX
Telephone: Sunbury-on-Thames 456

Telegrams & Cables: THERMOSTAT, SUNBURY-ON-THAMES, TELEX
Telex: 2-2742 TEDDCONTSNBRY

THE BUSH PEOPLE for NITRIDED JIG BUSHES and LINERS

NEW CATALOGUE AVAILABLE ON REQUEST

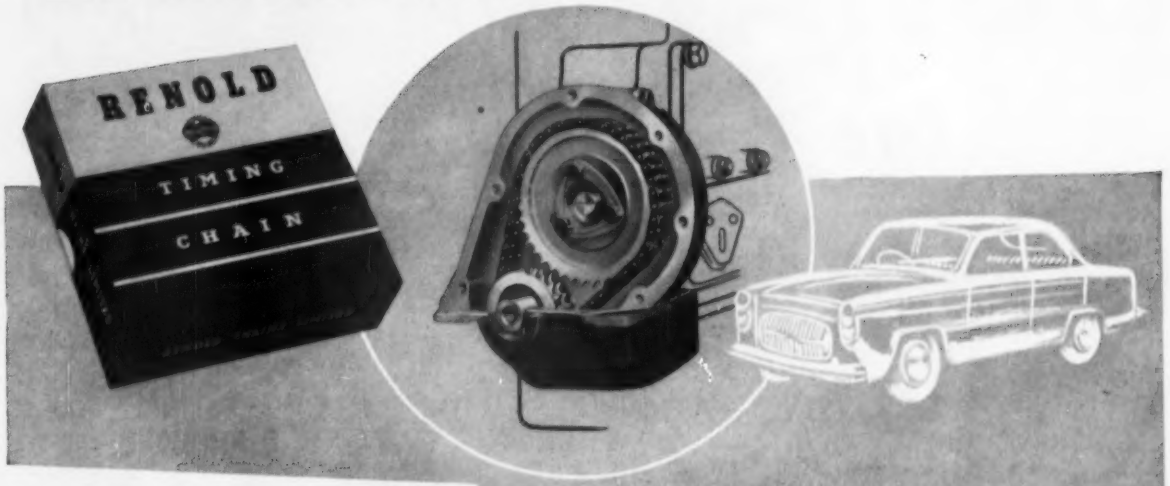
These jig bushes and liners are manufactured in accordance with B.S.S. 1098:1953, the recommended sizes for the jig plate holes being in accordance with British Standard for B limits (B.S.S. 164:1941).

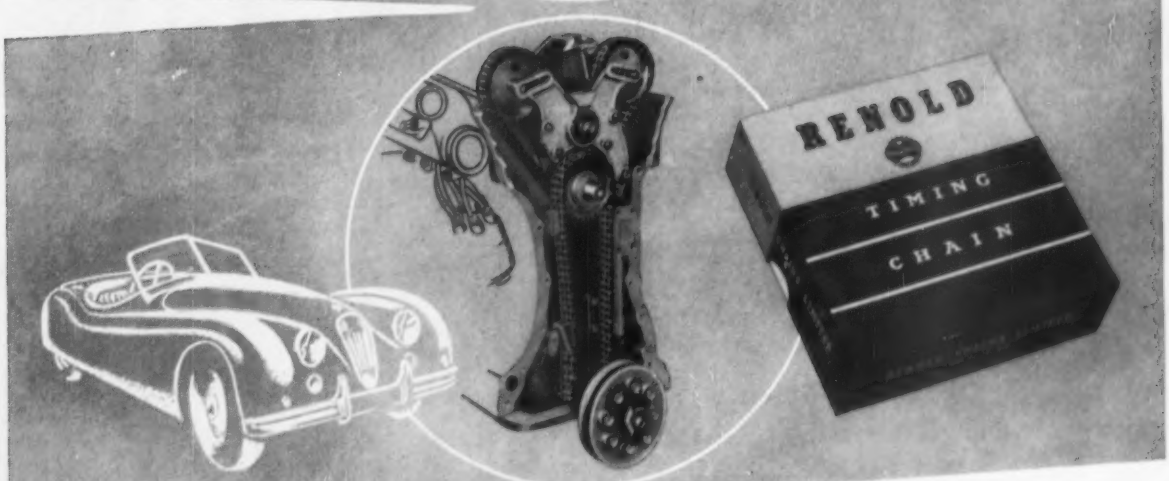
Established 30 years

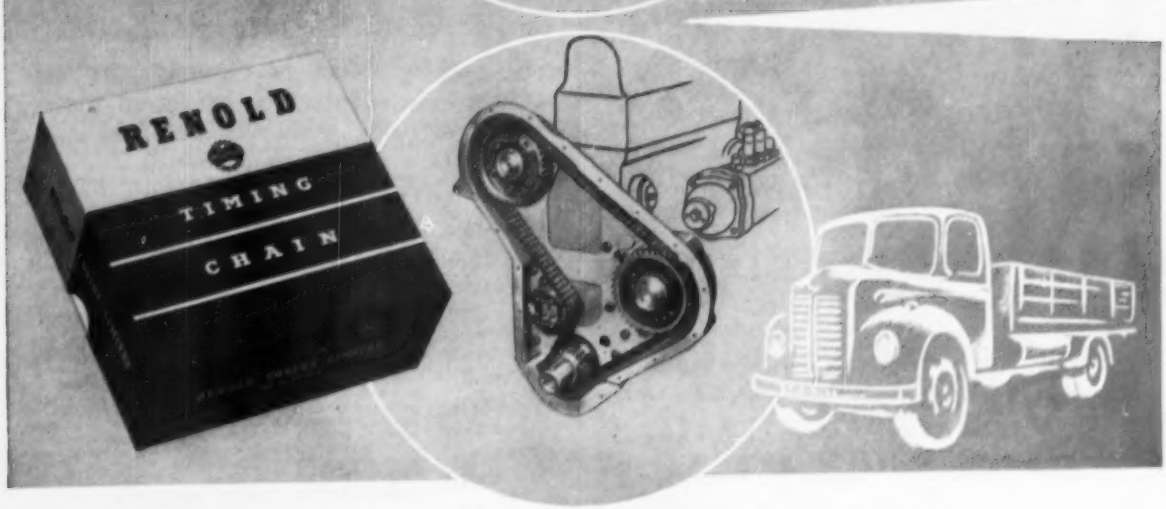
LAWRENCE Bros. MILLWARD LTD
WICKERSLEY
ROTHERHAM
Tel. Wickersley 2041-2

Collier's
TRADE MARK
WORM DRIVE
HOSE CLIP
The Most Positive Worm Drive
The slots are pierced right through the band, thus affording the worm or screw an absolutely certain grip under all conditions.

RENOLD TIMING CHAINS







RENOLD CHAINS LIMITED · MANCHESTER

SCRAP for COHEN'S

COHEN'S for SCRAP

GEORGE THE 600 GROUP **COHEN**

SONS AND COMPANY LIMITED

RAW MATERIALS DIVISION

Experts in Scrap since 1834

BROADWAY CHAMBERS, LONDON, W.6

'Phone : Riverside 4141 • *'Grams :* Coborn, Telex London

And at 600 Commercial Rd., E.14 · Bidder St., Canning Town, E.16
Bath · Belfast · Birmingham · Hebburn-on-Tyne · Leeds
Luton · Manchester · Sheffield · Swansea

MJ/553/R319

There's gold in the sea . . . In a thousand million pints of sea-water there may be as many as 250 pints of gold. Now gold, by the pint, is lovely stuff. So why don't we all get after it? Well, you see . . . it's just a little bit difficult to extract.

In hundreds and hundreds of manufacturing processes, solvents are used—and wasted. They just float off into the air. Now solvents are expensive things, so why don't we pull them back again? Goodness knows . . . because, with Active Carbon, it's just too easy . . . **There's gold in the air!** for the man who reads about Active Carbon and Solvent Recovery, and telephones **SUTCLIFFE SPEAKMAN**

AND COMPANY LIMITED, LEIGH, LANCASHIRE. TEL: LEIGH 94.
LONDON OFFICE: 2 CAXTON ST., WESTMINSTER, S.W.1. TEL: ABBEY 3085

VOLUME 3

SERVICING GUIDE

to British Motor Vehicles

A VOLUME OF ESSENTIAL DATA NOT AVAILABLE FROM ANY OTHER SOURCE

Following the very wide success of the previous volumes of the Servicing Guide, this latest publication brings up-to-date the information on the vehicle and engine servicing of many 1953-54 and some 1955 models. Bound in a single volume and arranged alphabetically in three groups by makes (cars, commercial vehicles, tractors and components), 25 of the eight page supplements and three four page supplements published in Motor Trader and British Automobiles Overseas provide an unequalled range of complete information.

. . . a new volume of this unique standardized SERVICE DATA

General tuning, overhauls and maintenance receive a thoroughness of treatment not available from any other source, as the bulk of the information has been obtained by personal research among the vehicle manufacturers. Ten of the new style Service Sheets use the "exploded" view technique to demonstrate the assembly and function of major components. Comprehensive wiring charts, specially compiled conversion and reference tables, illustrated glossary of technical terms and a revised treatment of tabular matter provide even more complete and more easily followed information.

SUPPLIES STRICTLY LIMITED—ORDER NOW! £2 10s.
Post 1/6 in United Kingdom only

TRADER PUBLISHING CO. LTD., DORSET HOUSE, STAMFORD ST., LONDON, S.E.1

PERFECTION by Simms

the SIMMS fuel injection pump *specially* designed to meet *your* need

The SPE-A series of injection pumps were developed to meet the specific needs of users of small, high-speed diesel engines. Experience has shown them to be admirably suitable for such diverse applications as farm tractors, marine and industrial engines, and road transport of every description. Here are some of their exclusive features:—

- Exclusive Simms pump elements give maximum resistance to wear from dirty or badly-filtered fuel.
- Latest Simms patent G.P. pneumatic governor ensures consistent performance at all speeds with a steady idling and closely controlled run out.
- Large diameter stiff camshaft withstands the higher operating pressures of modern conditions.
- New method of adjustment simplifies calibration and reduces backlash.
- Pump body is split horizontally into two halves to facilitate internal accessibility.
- 3, 4 and 6 cylinder models available.

Simms Fuel injection, lighting and starting equipment

SIMMS MOTOR UNITS LIMITED

OAK LANE, EAST FINCHLEY, LONDON, N.7

Telephone: FINchley 2262 (20 lines)
Telegrams: Simotunit, East Finch, London, N.7

S.1

angular motion faithfully transmitted

Light Series Universal Joints are available in special designs for aircraft use, made in light alloy to Spec. L.40, anodised, with hardened ground steel trunnion pins, cadmium plated. They are designed with shank diameters to suit bore of standard aircraft tube and will withstand moderate tension or compression loads. Made in a wide range of sizes, they can be supplied with covers as required.

Patent Universal ball joint combines high load capacity, simplicity of design and 92-98% efficiency (N.P.L. certified).

Hooke's Type Universal joint is suitable for high speeds and is inexpensive to fit.

Grease retaining Covers are available for all types and sizes of joints.

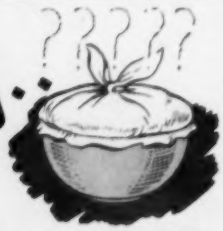
Air Ministry Gauge Test House Authority 09755/31

THE MOLLART ENGINEERING COMPANY LTD.

KINGSTON BY-PASS · SURBITON · SURREY · ENGLAND

Tel: ELMBRIDGE 0033-7 Grams: PRECISION, SURBITON

the proof of the pudding...

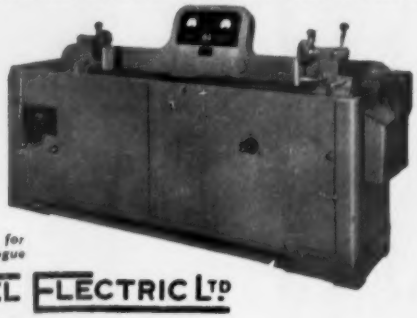


IT'S ALRIGHT FOR PUDDINGS—BUT IN THE CASE OF ENGINEERING COMPONENTS IT'S DIFFERENT —TRIAL & ERROR WON'T DO—THE INFALLIBLE TEST FOR HIDDEN FLAWS IS THE

FEL ELECTRIC

ELECTRO-MAGNETIC CRACK DETECTORS

Model U4/5



Send for Catalogue

FEL ELECTRIC LTD

41 SIDNEY ST., SHEFFIELD, 1.

The HEAVIER the duty the GREATER the need for

Don

SINTERED FRICTION MATERIALS

Unsurpassed for

* *Smoothness of operation*
* *Frictional stability*
* *Long operational life*

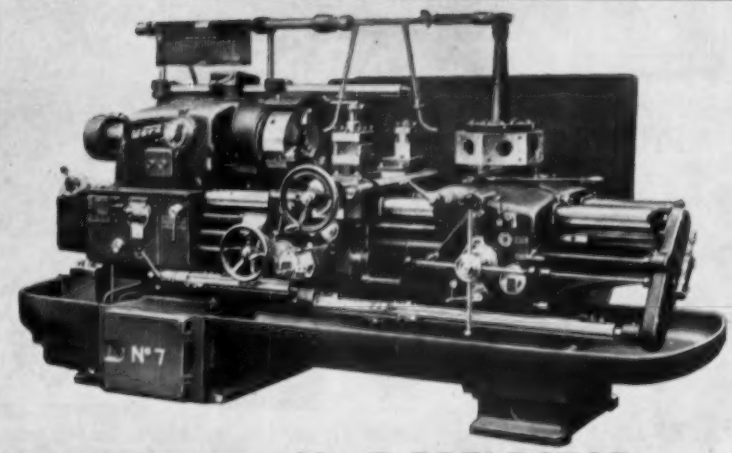
Enquiries to

SMALL & PARKES LTD

HENDHAM VALE WORKS, MANCHESTER 9 COLlyhurst 2511

LONDON OFFICE: 76 VICTORIA ST., SW1 VICtoria 1845/6

For Maximum Production



Capacity: 2¾ in. dia. hole through spindle. 16 in. dia. swing over stainless steel bed covers.

Spindle: Mounted in ball and roller bearings.

Powerful metal-to-metal cone clutches transmit power through ground gears.

New features include patented hydraulic preselecting speed change system allowing for setting any operation speed whilst the previous operation is running. Maximum production is ensured by making full use of Tungsten Carbide cutting tools.

Please write for particulars of our full range of Capstan & Turret Lathes

Ward

No. 7 PRELECTOR
COMBINATION TURRET LATHE

H. W. WARD & CO. LTD

SELLY OAK TELEPHONE — BIRMINGHAM 29 SELLY OAK 1131

W 608

Foremost!

EXACTA

STANDARDISED

PRESS TOOL DIE SETS

Now also available fitted with

EXACTA SUPER-PRECISION BALL BEARING BUSHES

As illustrated

Exacta standardised Press Tool Die Sets are available in an extensive range of types and sizes to suit practically all requirements. Their low initial cost and guaranteed quality and precision, combined with an exceptional delivery service and proved dependability in production commend them to discerning Engineers everywhere and they are now specified as standard tooling equipments by a vast number of progressive organisations throughout the world.

Save time in Drawing Office, Toolroom and Press Shop. Produce better pressings with fewer rejects and longer tool life. Increase output and reduce costs.

Send for our 1955 Catalogue of Tool Makers' Specialities.

COLEY BROS. (TOOLS) LTD

KINGS NORTON - BIRMINGHAM, 30

Telephone: KINgs Norton 2576-2580 *Telegrams: "COLBRO" Birmingham*

DARWINS
SPECIAL STEELS *used in*

THE NEW
Standard Vanguard III

THE DARWINS GROUP
SHEFFIELD ENGLAND

D75

P.V.C. WING PIPINGS, as supplied to leading motor manufacturers and body builders at home and abroad, have proved that plastic materials survive the severest tests. Whether as standard fittings used as wheel arch pipings or specially designed joint mouldings our sections are guaranteed to meet your particular requirements. Extrusions are our business — not just a department.

Please write for brochure on extrusions for the motor industry.

C. & C. MARSHALL LTD.
PLASTRIP HOUSE
OAKLEIGH ROAD NORTH, LONDON, N.20
Telephone: Hillside 5041 (3 lines) Cables: Tufflex, London
Telegrams: Tufflex, Norfinch, London

TUFFLEX

Weathershields' 3-way Lift
HINGED ROOF-VENTILATOR
Specified by Britain's leading Coachbuilders

Easily adjustable to 3 positions; each unit supplied complete ready for painting and screwing into position; made to suit any size opening to recommended maximum of 3' 0" square. Available in plain Perspex or in a range of attractive colours.

Full technical data on request.

'Phone: MID: 5876
'Grams: "QUIPIT, B'ham"

Weathershields Ltd
BISHOP STREET, BIRMINGHAM, 5.

MASON Bros. (JIGS AND MOULDS) LTD.

Designers & Manufacturers of
PRESS TOOLS
JIGS & FIXTURES
GAUGES
MULTI-DRILLING HEADS

GENEVOISE JIG-BORING
PLASTIC MOULDS
KELLER DIE-SINKING

Designing & Drafting to the Trade

28, STATION RD. ACOCKS GREEN
BIRMINGHAM 27.

Telephone: Acocks Green 4131

SPECIALISTS IN
THE PRODUCTION
OF SMALL REPETITION
GREY IRON CASTINGS

CASTINGS

in

GREY IRON WHITEHEART MALLEABLE

or

NON-FERROUS METALS

●

GEORGE WEARING LTD

CARTERS GREEN FOUNDRY
WEST BROMWICH

TEL: WEST BROMWICH 0092
TELEGRAMS: "WEARING" WEST BROMWICH

ESTABLISHED 1850

When you want to send anything – anywhere

ABC GOODS TRANSPORT GUIDE

will tell you how

Transport managers, despatch managers, and consignors in all industries will find this new edition of the ABC GOODS TRANSPORT GUIDE—the largest ever—an invaluable aid to their work. With its help they can find the nearest and quickest means of despatching goods of all kinds.

Long distance road transport operators—independent and British road services—local carriers, railway district offices, wharfingers, warehouse keepers, canals and coastwise shipping, and air freight services, are all listed to help YOU send YOUR goods to any part of the country.

Order your copies of the two 1956 issues . . . NOW. And, to make sure you are constantly up to date with alterations in this ever-changing industry, why not enter a standing order for all issues as published? We'll invoice you annually in advance.

ALL THE UP-TO-DATE INFORMATION YOU NEED FOR 7s. 0d. A YEAR

•POST THIS ORDER FORM TO-DAY

Published in half-yearly issues.
January-June & July-December
Annual Subscription 7s. 0d.

Please enter my order for the 1956 issues of the ABC GOODS TRANSPORT GUIDE (Jan.-June/July-Dec.) for which I enclose remittance for 7s. 0d.

★ Thereafter please continue my subscription until further notice and invoice me annually in advance.

Please Print. ★ Delete if not applicable

NAME .....

ADDRESS .....

.....

.....DATE.....

POST TO ABC GOODS TRANSPORT GUIDE, ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD ST., LONDON, S.E.1.

Casting Control . . .

The known behaviour of piston alloys under varying conditions is a prime consideration in casting. Correct cooling of the casting must take place if complete homogeneity and freedom from porosity is to be achieved. The Specialloid Hydraulic Die Casting Machines have been so designed that the cooling rate is controlled — coolant being applied both to core and die, resulting in unvarying quality of every piston.

For maximum performance, specify

Specialloid PISTONS

SPECIALLOID LTD., BLACK BULL STREET, LEEDS, 10 *Telephone: LEEDS 31471/7*

---

cold forged precision by

LINDLEY'S

QUALITY BOLTS, NUTS and SET SCREWS

C. LINDLEY & CO. LTD., ENGLEFIELD ROAD, LONDON N.1

Phone: CLissold 0643 (4 lines) Grams BEAUVOIR, NORDO, LONDON

MEKELITE

GEARED JOINT

INDUSTRIAL LIGHTING UNITS

For wall, bench or machine mounting. Catalogue sent free on request

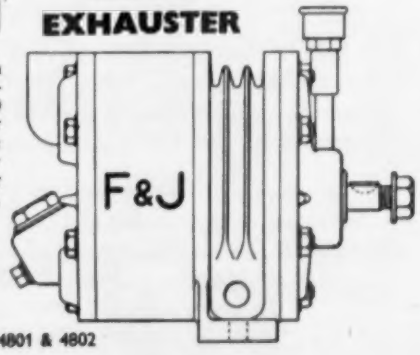
MEK-ELEK Engineering Ltd. MITcham 3072

17, Western Road MITCHAM, Surrey

F&J

E.300 EXHAUSTER

● Very high efficiency ● self-contained ● 300 cu. ft. per hour ● low price ● weighs only 19 lbs. ● Other sizes available.



FEENY & JOHNSON LTD.

WEMBLEY

Phone: WEMbley 4801 & 4802

Next time you fit a

SHOCK ABSORBER-

insist on

NEWTON

TRADE PRODUCT MARK

REGISTERED

Hydraulic

SUSPENSION CONTROL UNIT

Standard Equipment on most British Commercial passenger-carrying vehicles

Manufactured under one or more of the following Patents

9017/54, 19978/53
688286, 629727
627170, 460851

★ **Send for illustrated Catalogue No. 226-1/1**

NEWTON & BENNETT LTD. VALETTA RD. LONDON W.3
Telephone Shepherds Bush 3443/6

Nelson stands on his column

Intal stands on its own good name

INTAL

THE INTERNATIONAL TWIST DRILL CO. LTD.

INTAL WORKS · WATERY ST. · SHEFFIELD · 3

Telephone: 23072-3 Telegrams: Fluted, Sheffield

OBTAINABLE FROM YOUR STOCKIST

London Stocks: 16, ALDERSGATE ST., E.C.1.

Phone: MON. 3505

Glasgow Stocks: 50, WELLINGTON ST., C.2.

Phone: CITy 6994

QUALITY CONTROL

at all stages of manufacture ensures a trouble free product . . . . the reason why most manufacturers use High Tensile Cylinder Head, Gear Box and other Studs made

by

YARWOOD INGRAM & Co. Ltd
PARKER ST. BIRMINGHAM. 16.
TELEPHONE: EDGbaston 3607.

AMAL

Component Specialists to the Motor Industry

AMAL LTD · HOLDFORD ROAD · WITTON · BIRMINGHAM 6

FOR ALL ENGINE PARTS

Nitrided Nitralloy Steels for all engine parts which are subject to frictional wear. Also for Gauges and Jigs.

NITRIDED *Nitralloy* NL STEELS

NITRALLOY LTD · ATLAS WORKS · SHEFFIELD 4

Telephone : 26646 Sheffield *Telegrams :* Nitralloy, Sheffield.

STEELS
IN MODERN INDUSTRY

A Comprehensive Survey by 29 Specialist Contributors.

General Editor W. E. Benbow, late Editor of IRON & STEEL. Specifies the steels best used in various engineering applications (bearing in mind the present need for economy), describes their general and special properties and how they may be surface finished for anti-corrosive and other purposes. This work—the latest, most comprehensive and authoritative on the subject—comprises 562 pages with 260 illustrations, and has a foreword by Dr. H. J. Gough, C.B., M.B.E., M.I.MECH.E., F.R.S.

ASSOCIATED ILIFFE TECHNICAL BOOKS

42s. net. By post 43s. 5d.

Obtainable at all booksellers or direct by post from:
DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1

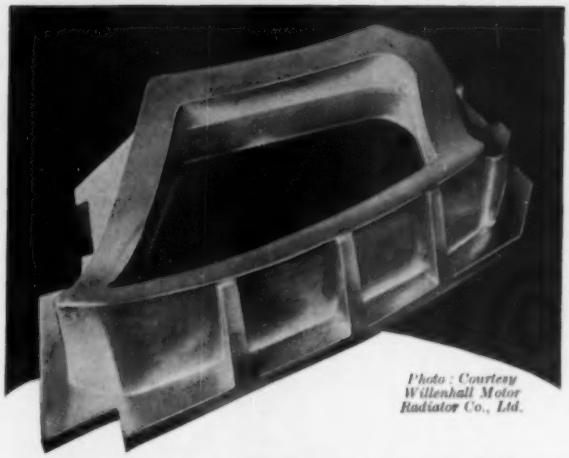


Photo: Courtesy Willenhall Motor Radiator Co., Ltd.

Press Tools & Stretcher Dies

AT A FRACTION OF THE COST using

KIRKSITE 'A'

LOW COST - SPEED - HIGH RECOVERY VALUE

Cost of dies made with KIRKSITE 'A' is only a fraction of those made of steel or cast iron, the more intricate the tool the greater is the saving. Use of KIRKSITE 'A' also means that dies can be produced in a few days eliminating long waiting periods for tools. A complete and speedy service for the production of both patterns and dies is operated. KIRKSITE 'A' data gladly sent on request.

Also the Hoyt Buyers' Guide, listing all the Hoyt products and services.

PRODUCTION RUNS OBTAINED FROM KIRKSITE PRESS TOOLS

Kirksite 'A' and Plastics:
Kirksite is specially suitable for metal moulds for Polyester resins, having a very long life under operating conditions with Polyesters, whether plain or reinforced.

200,000	Petrol tank pressings in 20 gauge steel from one KIRKSITE punch.
60,000	Aircraft jettison tanks in 16 gauge steel.
20,000	Delivery van sides in 20 gauge steel.
20,000	Runs in aluminium alloy sheet without any appreciable wear on tools.
50,000	Special plastic helmets on one set of KIRKSITE tools.
25,000	Special rubber parts from a KIRKSITE mould.

All the above tools were still serviceable.

HOYT LONDON

METAL CO. OF GT. BRITAIN LTD.

DEODAR ROAD, PUTNEY, LONDON, S.W.15.
Telephone: VANdyke 6061.

PLAIN BEARINGS · ANTI-FRICTION METALS
BRONZES & LEAD BRONZES · FUSIBLE ALLOYS, ETC.

DESIGNED FOR THE MOTORIST

'HERON'
Tappet Spanner Sets, incorporating the latest research in lightweight spanner design.

'WRYNECK'
A Half-Moon Ring Wrench designed to give access to certain obstructed nuts, such as exhaust manifold and starter nuts.

'WREN'
A shortened version of the well-known 'KESTREL' Ring Wrench.

Obtainable from all recognised Tool and Motor Accessory Stockists.

Garringtons

A MEMBER OF THE GKN GROUP OF COMPANIES

GARRINGTONS LIMITED, BROMSGROVE, WORCS. ENG.

CLASSIFIED ADVERTISEMENTS

RATE 4d. per word, minimum 4/-. Each paragraph charged separately. Box number 5 words—plus 1/-. Advertisements for the February, 1956, issue should be to hand not later than first post 24th January. No responsibility accepted for errors.

BALL BEARINGS

BALL and Roller Bearings. All types and sizes. Largest stocks, lowest prices. Same day despatch. Claude Rye Bearings, 895-921, Fulham Road, London, S.W.6. Renown 6174 (Ext. 24). [4964

PATENTS

THE Proprietor of British Patent No. 719486, being a brake for private and commercial vehicles entitled "Concentric Cam," offers same for licence or outright sale, to ensure the practical working of same in Great Britain. Enquire, Re-line-1 Brake Drums Ltd., 76 Stoke Newington High Street, N.16. [5037

PLANT FOR SALE

ONE CLIFTON & BAIRD Hot Sawing Machine.
ONE SAMUEL PLATT Friction Drop Stamp. Battery, 3 Stamps, 12' 0" Lift.
ONE ACASTER Trimming Press.

ONE 1½" PRATT & WHITNEY Trimming Press.
ONE SAMUEL PLATT Swaging Press.

ONE 5½" SCHEISS DEFRIES Forging Machine.
ONE 3½" AJAX Forging Machine.

MITCHELL, SHACKLETON & CO. LTD., Vulcan Works, Patricroft, Manchester. [5114

SERVICES OFFERED

DESIGN Office Capacity available for Mechanical and Production Engineering. Special Machines and Projects. Norris Brothers Ltd., 53 Victoria Street, London, S.W.1. Tel.: Abbey 5444 [5099

SITUATIONS VACANT

CHIEF Draughtsman required for tipping gear and hydraulic equipment manufacturers. Applicant must be able to control staff and supervise engineering procedure; minimum technical qualification H.N.C. Pension scheme and excellent working conditions. Apply in writing to the Chief Engineer, Telehoist Limited, Cheltenham. [5118

SITUATIONS VACANT

YOUNG Development Engineer required to take charge of progressive office engaged in the design of "off the road" automotive products and mechanical handling equipment. Excellent opportunity for a man with drive, initiative and a flare for this type of work. Box 8263, c/o Automobile Engineer. [5119

WORKS Superintendent required for modern factory, Hertfordshire. Fully experienced line production machines producing automotive transmissions. Previous practical experience in automotive industry highly desirable. Four figure salary. Write, stating fullest details of background and present salary, to Box T.795, c/o Streets, 110 Old Broad Street, E.C.2. [5120

ASSISTANT Technical Engineer/Designer for automobile testing and development. Applicants should be educated to National Certificate level, have served works apprenticeship, and possess drawing office experience. Superannuation scheme, good initial salary. Location of appointment—new factory, Hertfordshire. Write with full details to Box T.732, c/o Streets, 110 Old Broad Street, E.C.2. [5116

MANAGER required by an old-established firm, manufacturing quality bodies for the Motor Industry, to be responsible for and to co-ordinate all production functions, in addition to the general administrative control of the factory.

CONSIDERABLE experience in this section of the Motor Industry and knowledge of production methods are absolutely necessary. It will be an advantage if this experience includes also the manufacture of motor chassis.

TO a man of initiative and drive who possesses the requisite experience the post offers a great opportunity, and the prospects are exceptionally attractive.

SEND details of experience, positions held, age and salary required, to Box 8376, c/o Automobile Engineer [5123

F. PERKINS LTD., of Peterborough, have the following vacancies in their Experimental Department, on diesel engine and long-range product development:—

(a) Engineers for research and development work. Must hold engineering degree or H.N.C. with experience in internal combustion engine research or development. Salary £800-£1,100, according to qualifications and experience.
(b) Engineers for field test work. Must hold engineering degree or H.N.C. with experience in the operation of high-speed diesel engined vehicles, agricultural equipment or stationary plant. Must be prepared to travel outside Great Britain. Salary £700-£1,000, according to qualifications and experience.
(c) Junior Engineers for research, development or field test work. Must hold engineering degree or H.N.C. Experience in research development or operation of diesel engined equipment an advantage. Salary £600-£800.

PENSION Fund in operation.

APPLY to Personnel Manager, F. Perkins Ltd., Peterborough. [5117

SITUATIONS VACANT

A YOUNG Engineer is required for the Research Department of a progressive engineering firm in the East Midlands. An Engineering Degree or its equivalent is essential and the applicant should be interested in vibration theory. The work of the Department includes the design, development and testing of various components for the motor, aircraft and other industries. Applicants should give full details of their qualifications and experience to Box 7917, c/o Automobile Engineer. [5112

MINISTRY of Transport and Civil Aviation: Vehicle Examiners. The Civil Service Commissioners invite applications for about 5 pensionable posts in various parts of England and Wales. Age at least 30 on 1st January, 1956. LONDON salary scale £720-£850. Somewhat lower in the provinces, and for women, but women's scales being improved under equal pay scheme. Prospects of promotion.

CANDIDATES must be first class mechanics and have had suitable training (H.N.C. in Mechanical Engineering or comparable evidence of technical education an advantage), followed by at least 3 years' practical experience of motor engineering in private or public service or equivalent experience in Forces. They must be able to work without supervision and to write concise reports. Full knowledge of Highway Code necessary. Experience of goods and public service vehicles in construction, repair and in driving expected.

FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S232/56. Completed applications must be returned by 4th February, 1956. [5121

LONDON County Council.

PADDINGTON Technical College. Two Assistants, Grade B. (a) To teach Mechanical subjects of O. & H. Nat. Certs. Should possess degree or equivalent qualification. (b) To teach subjects for C. & G. Motor Vehicle Mechanics and Technicians and Institute of Motor Industry Section C Examinations.

GRADE A Assistant to teach O.N.C. maths. to S3 level and, if possible, Engineering Science to S2 level. Burnham F.E. salary scales—Grade B, £561×£25—£1,012. Grade A, £486×£18—£917. Individual commencing and maximum salary according to age, qualifications and experience. Application forms from Secretary at College, Saltram Crescent, W.9, returnable by 27th January, 1956. (2115.) [5122

A.E.C. LIMITED, SOUTHALL

A vacancy exists for a fully qualified Engineer with experience in the design and manufacture of high speed oil engines to take charge of development and research. Some knowledge of gas turbine work would be an advantage. Applications giving particulars of experience, positions held and salary required should be addressed to the Chief Engineer, A.E.C. Limited, Windmill Lane, Southall, Middx. Applications will be treated in confidence.

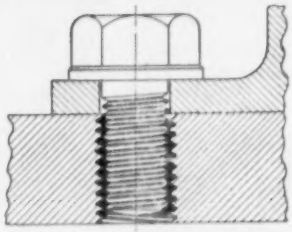
SOLVE PROBLEMS OF ABSENTEEISM FLOOR SPACE WELFARE

WITH THE **AIR-DRY**
SIEBER HANGER SYSTEM
Patent No. 415653 Des. Reg. No. 789558

✱ HEALTH damp clothing thoroughly dried and aired. ✱ HYGIENE no musty cupboard odour, no dirt traps. ✱ SPACE floor space saved pays for initial outlay. ✱ COST low—yet service everlasting.
Installed in Factories, Stores, Shops, Hospitals, etc.

JAMES SIEBER EQUIPMENT COMPANY LTD.
Africa House, Kingsway, London, W.C.2.
Telephones: HOLborn 5121 and 4531.

WIRE
THREAD INSERTS



FOR NEW DESIGNS AND SALVAGE
CROSS MFG. CO. (1938) LTD.
COMBE DOWN · BATH
Tel.: COMBE DOWN 2355/6

SWISS JEWELLED LEVER
STOP WATCHES
ALL ARE FULLY GUARANTEED

Whatever use you have for a "Timer" use a PRESTONS STOP-WATCH. They are all top-quality Swiss precision instruments.

Send for our Price List, "Swiss Timers in Industry"

PRESTONS LTD. TEL. BOLTON 874-877
BOLTON (EST. 1869) LANCS.

★★★★★★
SIX STAR
Sellotape BRAND
THE NEW IMPROVED MASKING TAPE
GORDON & GOTCH LTD. SELLOTAPE DIVISION
39-40 FARRINGDON ST. LONDON, E.C.4.

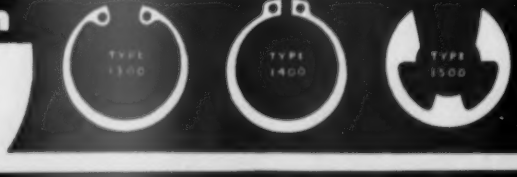
COTTON BAGS
FOR SPARE PARTS Etc.
Walter H. Feltham & Son Ltd
Imperial Works, Tower Bridge Road
Telephone: HOP 1784 LONDON, S.E.1

ENGINEERING BUSINESS
For Sale as Going Concern
NORTH OF LONDON

Modern, Freehold Single-storey Factory, 15,000 sq ft. Land for extension. Engineering Plant, Machinery, Equipment and Goodwill. Good and skilled labour force. Price for whole £60,000. Box No. 8170.

Anderton

Cyril Circlip's Stock ranges from ⅛" to 10"



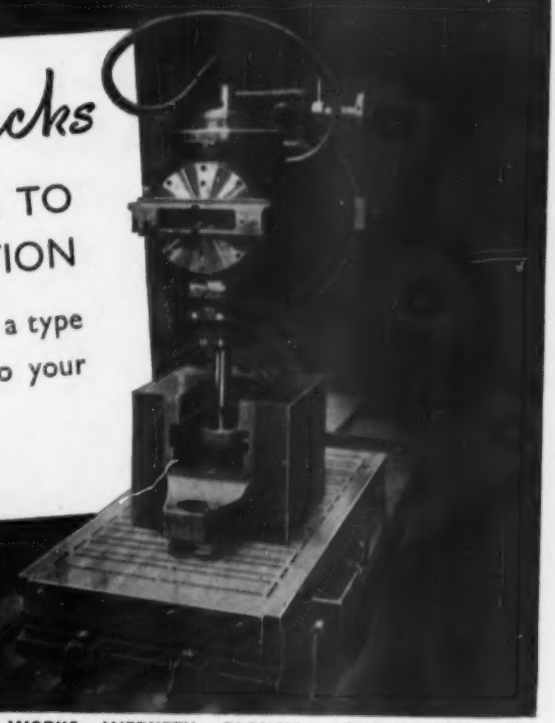
Write for **DATA SHEETS** *to Dept. A.1*
ANDERTON SPRINGS LTD · BINGLEY
Phone: Bingley 2226 & 2351
Grams: 'Circlips Bingley'
CIRCLIPS

Magnetic Chucks

IN STANDARD SIZES OR TO YOUR OWN SPECIFICATION

Our catalogue will help you select a type and size of chuck most suitable to your own needs.

Write for your copy today.



J. H. HUMPHREYS & SONS, LTD., BLACKRIDING ELECTRICAL WORKS, WERNETH, OLDHAM. PHONE: MAI 1651

Quicker paint repairs with **G.E.C.**

INFRA-RED PAINT REPAIR UNITS

- all coats applied — and dried — in **one** day
- no blooming

Standard drying times for small patches

Primers and stoppers	10 minutes
Cellulose finishes	20 minutes
Synthetic finishes	30 minutes

Full details available on request.

The General Electric Co. Ltd., Magnet House, Kingsway, W.C.2.

NEVER COULD UNDERSTAND ANYTHING MECHANICAL

To help your design department, the Lewis Spring Co. offer a 40 page booklet on spring design, full of technical data. 2/6 post free.

You'd be surprised how many giant creative brains boggle at mechanical details. "Thank heaven for Lewis" they say, "I can depend on them to design the right springs for the job." Why don't you try us too? "Leave it to Lewis" has been said with a sigh of relief for over thirty years now.

THE LEWIS SPRING CO. LIMITED

RESILIENT WORKS, REDDITCH

'Phone: Redditch 720/1/2.

London Office: 122, High Holborn, W.C.1 **'Phone: Holborn 7479 and 7470**

LEAVE IT TO **Lewis** *OF REDDITCH*

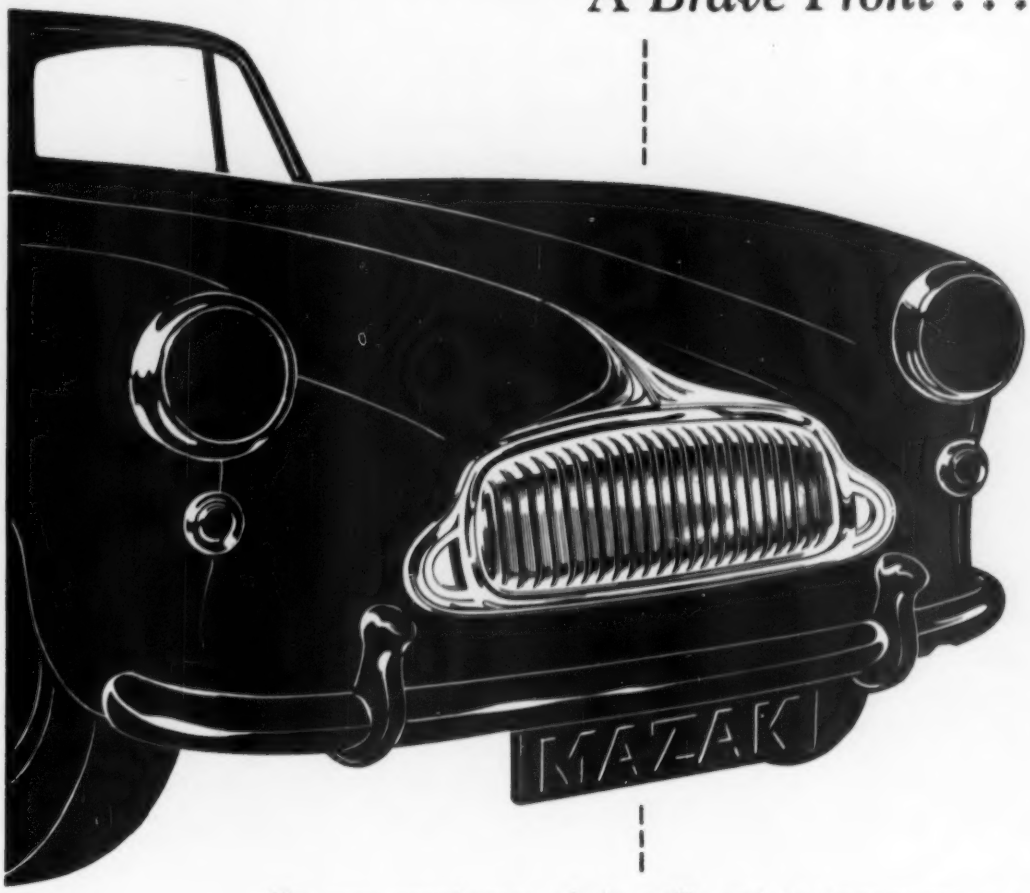
SPRINGS, SPRING CLIPS
PRESSWORK, WIRE FORMS
VOLUTE SPRINGS

INDEX TO ADVERTISEMENTS

	PAGE
Abingdon King Dick Ltd.	84
"ABC" Goods Transport Guide"	119
Acheson Colloids Ltd.	58
Adamant Engineering Co. Ltd.	31
A.E.C. Ltd.	124
Aluminium Bronze Co. Ltd.	82
Amal Ltd.	122
Anderton Springs Ltd.	124
Angus, George, & Co. Ltd.	28
Archdale, James, & Co. Ltd.	89
Armstrong Whitworth & Co. (Pneumatic Tools) Ltd.	14
Automotive Products Co. Ltd.	5, 6, 7, 8
Barber & Colman Ltd.	110
Benton & Stone Ltd.	109
Birkett, T. M., Billington & Newton Ltd.	97
Birlec Ltd.	20
Birmingham Aluminium Casting (1903) Co. Ltd.	Cover iv
Black & Decker Ltd.	18
Borg-Warner Ltd. (Morse Chain Division)	93
Bound Brook Bearings Ltd.	73
Box No. 8170	124
British Belting & Asbestos Ltd.	Cover ii
British Electrical Development Association	24
British Geon Ltd.	32
British Oxygen Co. Ltd., The	66
British Piston Co. Ltd., The	35
British Thermostat Co. Ltd., The	112
British Thomson-Houston Co. Ltd.	110
Brown, David, Corporation (Sales) Ltd., The	41, 67
B.S.A. Tools Ltd.	68
Carobronze Ltd.	100
C.A.V. Ltd.	38
Clancey, G., Ltd.	98
Clayton Dewandre Co. Ltd.	46
Clifford, Chas., Ltd.	102
Cohen, George, Sons & Co. Ltd.	114
Cole, E. K., Ltd.	106
Coley Bros. (Tools) Ltd.	117
Collier & Collier Ltd.	112
Concentric Manufacturing Co. Ltd.	95
Cooper & Co. (Birmingham) Ltd.	86
Copper & Asbestos Washer Co. Ltd.	100
Coventry Motor Fittings Co. Ltd.	47
Crofts (Engineering) Ltd.	52
Cross Mfg. Co. (1938) Ltd.	124
Dawins Ltd.	118
Desoutter Bros. Ltd.	9
"Diesel Maintenance"	104
Dobbie, McInnes Ltd.	108
Drummond - Asquith (Sales) Ltd.	21
Elgar Machine Tool Co. Ltd.	62
E.N.V. Engineering Co. Ltd.	3
Feeny & Johnson Ltd.	120
Fel Electric Ltd.	116
Feltham, Walter H., & Sons Ltd.	124
Ferodo Ltd.	72
Firth Brown Tools Ltd.	39
Firth, Thomas, & John Brown Ltd.	69
Fischer Bearings Ltd.	Cover i
Fletcher Miller Ltd.	96
Fry's Metal Foundries Ltd.	90
Fuller, Horsey, Sons & Cassell	88
Funditor Ltd.	82
Gatringtons Ltd.	123
General Electric Co. Ltd., The	53, 101, 125
Girdex Engineering Co. Ltd.	92
Girling Ltd.	36
Glacier Metal Co. Ltd., The	103
Gloucester Foundry Ltd.	91
Gordon & Gotch Ltd.	124
Guest, Keen & Nettlefolds (Midlands) Ltd.	102
Hale & Hale (Tipton) Ltd.	110
Hardy Spicer & Co. Ltd.	107
Harper, John, & Co. Ltd.	59
Heenan & Froude Ltd.	12, 16, 17
Herbert, Alfred, Ltd.	11
Hey Engineering Co. Ltd.	98
Hoffmann Manufacturing Co. Ltd., The	77
Holroyd, John, & Co. Ltd.	51
Hoyt Metal Co. of Great Britain Ltd., The	123
Humphreys, J. H., & Sons	125
I.C.I. (General Chemicals, Heat Treatment) Ltd.	40
I.C.I. (Marston Excelsior) Ltd.	96
Imperial Smelting Corporation	Cover iii
International Twist Drill Co. Ltd., The	121
Jackson H., Ltd.	25
Jackson & Bradwell Ltd.	90
Johnson & Johnson (Gt. Britain) Ltd.	104
Kayser Ellison & Co. Ltd.	19
Kirkstall Forge Eng. Ltd.	23, 61
Lawrence Bros. Millward Ltd.	112
Laycock Engineering Co. Ltd.	29
Laystall Engineering Co. Ltd.	4
Lee, Arthur, & Sons Ltd.	75
Lewis Spring Co. Ltd., The	126
Lincoln Electric Co. Ltd.	37
Lindley, C., & Co. Ltd.	120
Linread Ltd.	83
Litchfield Bros. Ltd.	105
Lloyds (Burton) Ltd.	42
Marshall, C. & C., Ltd.	118
Mason Bros.	118
Mek-Elek Engineering Ltd.	120
Metalastik Ltd.	26, 27
Midland Motor Cylinder Co. Ltd., The	45
Mollart Engineering Co. Ltd.	116
Morgan Crucible Co. Ltd., The	76
Newall, A. P., & Co. Ltd.	56
Newton & Bennett Ltd.	121
Nitralloy Ltd.	122
Park Gate Iron & Steel Co. Ltd., The	85
Payne, P. P., & Sons Ltd.	74
"Plastics Progress"	84
Plessey Co. Ltd.	70
Prestons Ltd.	124
Quasi-Arc Ltd.	13, 63
Ransome & Marles Bearing Co. Ltd.	65
Renold Chains Ltd.	113
Richards, Chas., & Sons Ltd.	106
R.J.H. Tool & Equipment Co. Ltd.	111
Rubery, Owen & Co. Ltd.	87
Rubber Bonders Ltd.	48
S. & D. Rivet Co.	104
Salter, Geo., & Co. Ltd.	30
Sandwell Casting Co., The	86
Selson Machine Tool Co. Ltd.	60
"Servicing Guide to British Motor Vehicles"	114
Sheffield Twist Drill & Steel Co. Ltd., The	55
Shell DERV	54
Shotton Bros. Ltd.	108
Sieber, James, Equipment Co. Ltd.	124
Silentbloc Ltd.	64
Simms Motor Units Ltd.	115
Skefko Ball Bearing Co. Ltd.	80
Small & Parkes Ltd.	34, 116
Smith W. H., & Son Ltd.	108
Specialloid Ltd.	120
Spencer, H. F., & Co. Ltd.	71
Steels Engineering Products Ltd.	99
"Steels in Modern Industry"	122
Super Oil Seals & Gaskets Ltd.	44
Sutcliffe, Speakman & Co. Ltd.	114
Tecalemit Ltd.	81
Terry, Herbert, & Sons Ltd.	2
Timken Detroit Axle Co.	78
Toledo Woodhead Springs Ltd.	33
Torrington Co. Ltd., The	43
Tucker, George, Eyelet Co. Ltd.	94
Udal, J. P., Ltd.	88
Vandervell Products Ltd.	22
Walker, M. W., & Staff Ltd.	106
Ward, H. W., & Co. Ltd.	117
Ward Thos. W., Ltd.	94
Wearing, Geo., Ltd.	119
Weathershields Ltd.	118
Wellworthy Piston Rings Ltd.	92
Weston, Chas., & Co. Ltd.	10
West Yorkshire Foundries Ltd.	15
Wickman Ltd.	1, 50, 57
Wild-Barfield Electric Furnaces Ltd.	49
Yarwood, Ingram & Co. Ltd.	122

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd.; Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Offices.

A Brave Front . . .



The very prominence of the grille and its importance as a dominant feature of motor-car styling, demands an attractive well-balanced design in harmony with the general body lines. Any motif or decorative detail must be clearly-defined, and the finish smooth and impeccable. With the further requirements of strength and economy, the obvious means of production is by die casting in MAZAK.

MAZAK

IMPERIAL SMELTING

U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

IMPERIAL SMELTING CORPORATION (SALES) LIMITED, 37 DOVER STREET, LONDON, W.1.

modifications location points design advice
machining problems quality maintenance

We do the worrying for you!

Our job doesn't stop once we have delivered castings . . . sold and forgotten . . . that's NOT our way of working! We are here to give customers the service they expect, a service that continues as long as our advice is needed.

Expert technicians follow up the delivery of your castings. They are at your disposal to answer any problems you may have regarding machining, location, modifications and anything else peculiar to your own special requirements . . . in short — we do the worrying for you! Another feature of the Birmal service is our Research and Development organisation. You can obtain technical help in the development of cast components and unbiassed assistance in the selection of the right alloy and casting process.

★ *Birmal supply aluminium and magnesium castings in the sand, gravity die and pressure die process, and zinc pressure die castings.*

you get more than a casting from BIRMAL

BIRMINGHAM ALUMINIUM CASTING (1903) COMPANY LIMITED

BIRMID WORKS · SMETHWICK 40 · STAFFORDSHIRE